MACHINERY

April, 1909.

DESIGN AND CONSTRUCTION OF ELECTRIC OVERHEAD CRANES—4.

BRAKES AND BRAKE MECHANISM.

R. B. BROWN.

BRAKES for electric cranes may be divided into two types, viz., solenoid, or magnetic brakes, and mechanical brakes. Electrical or magnetically operated brakes are generally ordinary strap or clamp brakes, which are held off by the action of a magnet or solenoid, electrically connected with the motor in such a manner that when the current is cut off from the motor from any cause, the magnet releases the spring or weight, as the case may be, and allows the brake to come into action. The solenoid commonly in use consists of a coil of wire connected in series with the motor, and a plunger working inside the coil as shown in Fig. 9, which represents, in a general way, the form of solenoids manufactured in several sizes by various electrical firms.

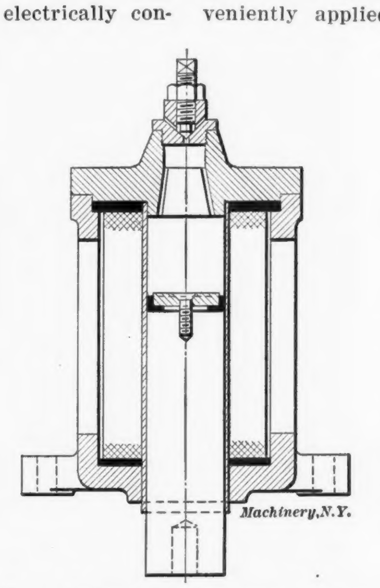


Fig. 9. Solenoid used to Operate Brake for Electric Cranes.

Solenoids should be so proportioned that their action is not delayed when the current has been cut off, due to residual magnetism. On the other hand, a too rapid application of the brake is to be avoided, since it has occasionally bent armature shafts; to effect this end the solenoid forms in itself a dashpot, the air being throttled in the small hole at the top of the body. Arrangements are usually made in the winding of the solenoid to enable it to lift off the brake when the controller is on the first contact, otherwise the motor would drive against the brake.

For cranes above five tons capacity the solenoid brake is applied principally as a means of stopping the motor quickly, to facilitate rapid reversal, and it should, of course, always be powerful enough to hold the full load in the event of the mechanical brake failing. The disadvantages of relying entirely on a solenoid brake are due to the fact that it does not permit of steady lowering, since, when the motor is reversed, the brake lifts entirely off and consequently allows the load to run down unchecked until the current is cut off again. This arrangement has been found fairly satisfactory for cranes under five tons (and is, in fact, often used on larger cranes), one reason being that the friction of the crab itself helps to retard a light load to some extent. A better method of lowering for small cranes is shown in Fig. 10, where an ordinary solenoid brake is used which can be released and controlled by a foot treadle for lowering.

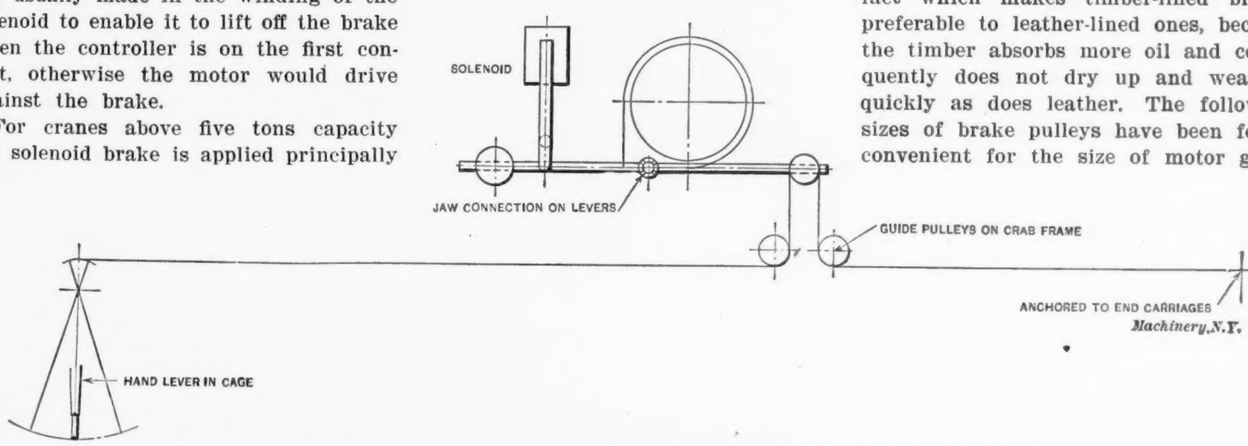


Fig. 10. Solenoid Brake, which can be released and controlled by a Foot Treadle for Lowering the Load.

When a crane is fitted with both a solenoid brake and an automatic mechanical brake, the principal function of the solenoid brake, as already stated, is to absorb the momentum of the armature and gear and stop the motor rapidly, and since this action must take place with the motor running in either direction, the clamp type of brake has been found the most suitable, although the ordinary type of strap brake is frequently used. The solenoid brake is most conveniently applied on the armature shaft itself, since the momentum is more readily absorbed at that point and a smaller solenoid can consequently be employed; but it is a mistake to cut the size of the solenoids too close.

For convenience, motors are sometimes made with the shaft extended at both ends, so that the driving pinion can be fixed on one end and the brake pulley on the other; this arrangement obviates the necessity of coupling a short shaft to the motor and providing an extra and somewhat expensive outer bearing. Brake pulleys are made of cast iron, and, while they should be as large as possible, in order to reduce the tangential force, at the same time the peripheral speed should not, if possible, be more than 2,000 to 2,500 feet per minute, or an inconvenient amount of heat will be produced. In any case, they will, of necessity, become more or less heated, a fact which makes timber-lined brakes preferable to leather-lined ones, because the timber absorbs more oil and consequently does not dry up and wear so quickly as does leather. The following sizes of brake pulleys have been found convenient for the size of motor given below, the full load speed being limited to 750 revolutions per minute for motors up to 20 B. H. P., and 500 revolutions for those above.

Brake Horse-power.	Diameter, inches.	Brake Horse-power.	Diameter, inches.
5	10	30	18
10	12	35	18
15	12	40	21
20	15	45	24
25	15	50	24

A compact and typical design of a clamp brake is shown in Fig. 11.

The calculations for all types of clamp brakes are identical, and the horse-power of the motor being given, it is necessary in the first place to find the size of the solenoid. Take for example a 20 B. H. P. motor running at 500 revolutions per minute. If the brake pulley is 15 inches diameter, the tangential effort will be

$$\frac{20 \times 33{,}000 \times 12}{500 \times \pi \times 15} = 335 \text{ pounds.}$$

The safe coefficient of friction for greasy wood on iron is 0.3; therefore, the force required at the center of the blocks will be $335 \times 0.3 = 100$ pounds.

The ratio of the levers depends on the stroke of the magnet. Suppose the stroke, in the present case, to be limited to 2 inches, and the blocks are adjusted to lift off ⅛ inch, the ratio will be $2 : 0.25 = 8$ to 1, and, consequently, the weight required to stop the motor will be $100 \div 8 = 12.5$ pounds. It is always advisable to allow for a little extra weight, say 25 per cent, in practice, to cover the momentum, etc., so that in the present example it would be better to provide a 15-pound weight. A small adjusting weight is added to make

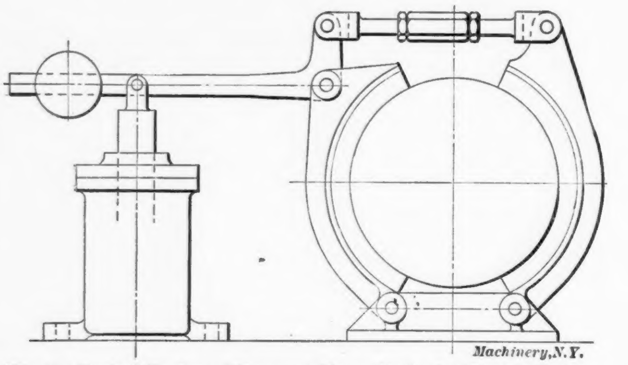


Fig. 11. Typical Design of Compact Clamp Brake for Electric Cranes.

up the difference between the weight of solenoid core and the actual weight required.

Several electrical firms supply an armature brake complete and self-contained on the motor, in which case the weight is generally replaced by a spiral spring.

When a strap brake is more suitable, as in the case shown in Fig. 10, the calculations are somewhat different. The size of the pulley remains the same as given in the previous table, and, as in the case of the clamp type, wood-lined straps are the most serviceable. Having found the tangential effort on the pulley, as before, it is necessary to proportion the levers to give the required pull on the strap. The quantity depends on the proportion of the pulley enclosed by the arc of contact of the strap, the value of coefficient of which will be found in Table VIII. In the diagram over this table it will be seen that if the tangential effort on the brake due to the load is acting in the direction shown by the arrow, the fixed end of the strap will be at F and the slack end, that

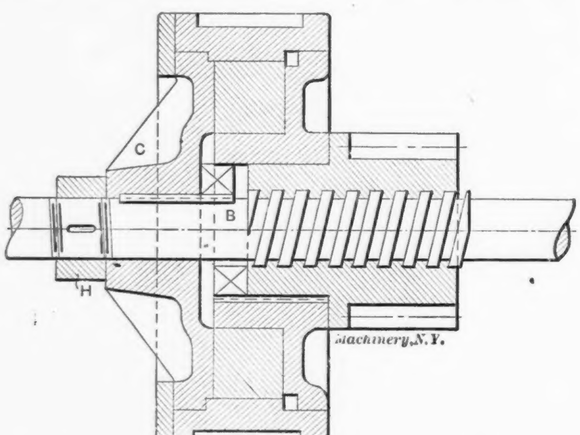


Fig. 12. Automatic Screw Brake for Overhead Electric Cranes.

is the end attached to the lever, at x. To find the pull on the slack end it is only necessary to multiply the tangential effort P by the value opposite the angle θ and under the coefficient μ. For example, the brake for a 10 H. P. motor running at 500 revolutions is 12 inches diameter. The tangential effort

$$P = \frac{10 \times 33{,}000}{\pi \times 1 \times 500} = 210 \text{ pounds.}$$

If $\theta = 210$ degrees, the value of $x = 0.5$ for wood blocks on an iron pulley. Therefore the pull at $x = 210 \times 0.5 = 105$ pounds. The pull on the fixed end can be found from the table in a similar manner, although a table is hardly necessary, since it will readily be seen that the pull at F will equal $x + P$, or the pull on the slack end plus the tangential effort.

The above coefficient may be found independent of the table by calculating the ratio of the tension $\frac{T}{T_1}$ in fast and slack ends of strap from the following formulas.

$$\frac{T}{T_1} = 2.718\ \mu\ \frac{L}{R}.$$

Where μ = coefficient of friction (0.3 for wood on iron).
L = length of contact in inches.
R = radius of pulley in inches.

For example, take the preceding case; then

$$2.718 \times 0.3 \times \frac{22}{6} = 2.99 = \frac{T}{T_1}.$$

$$P = T - T_1; \text{ but } T = 2.99\ T_1.$$

Therefore $P = 2.99\ T_1 - T_1 = 1.99\ T_1$, or $T_1 = \frac{P}{1.99}$.

Since $P = 210$ pounds, $T_1 = \frac{210}{1.99} = 105$ pounds.

And $T = P + T_1 = 210 + 105 = 315$ pounds.

The short lever should be given about half an inch travel, to allow the strap to lift as clear as possible of the pulley; therefore, if the magnet has a stroke of two inches, the ratio of leverage will be 4 to 1, and the pull required $105 \div 4 = 26$

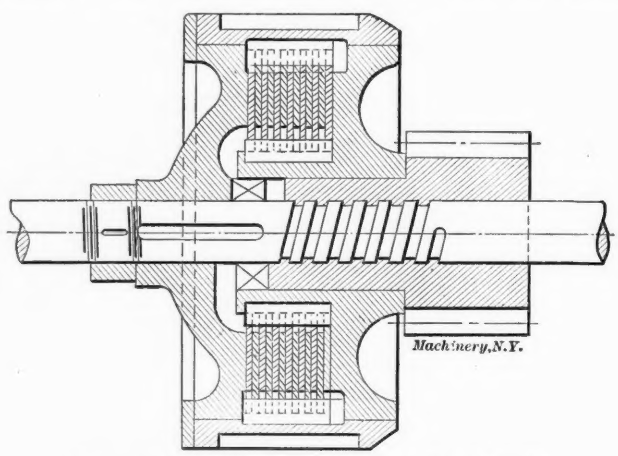


Fig. 13. Friction Brake with a Number of Friction Disks.

pounds, showing that this type of brake requires a larger magnet than the clamp type.

Brake straps should be made of a good quality mild steel or wrought iron; they can then be stressed up to 5 tons per square inch in the net section, and consequently kept light and pliable.

There are several forms of automatic mechanical brakes used on overhead travelers, foremost among which is the screw brake, as shown in Fig. 12. This brake consists of a pinion of phosphor bronze, or steel, bushed with gunmetal, mounted on a thread which is cut in one of the intermediate driving shafts B. The steel or iron casting C is fixed to the driving shaft by means of a key which allows the necessary lateral movement for the adjustment, regulated by the nut H. The ratchet D, which is cored out to hold oil, and bushed with gunmetal, runs loose on the boss formed by the jaws. All working faces are preferably lined with gunmetal. One or two pawls, according to the size of the brake, engage with the ratchet, being thrown out of gear by a suitable arrangement.

The action of the brake is as follows: When lifting the load, the resulting pressure on the pinion due to the screw holds it hard up against the ratchet face and, the pawls having been lifted out of gear, the whole brake revolves together without resistance. As soon as the lifting ceases and a slight reverse has taken place, the pawls fall into gear, and the load is held secure by friction. In order to lower the load, the motor must be reversed and run on light power, this having the effect of reducing the pressure on the friction faces and allowing the load to slip steadily.

Some makers employ several friction disks in place of the two faces in the form just described. This design is shown in Fig. 13. This type is more powerful in proportion to its size than the other design, but is preferably enclosed in an oil bath to ensure complete lubrication between all the faces. The two jaws in both types are necessary to prevent the pinion backing from the face when the load is too light to keep them together, as when lowering the empty hook.

To calculate the size of the brake shown in Fig. 12, it is necessary to make the diameter such that, allowing for the

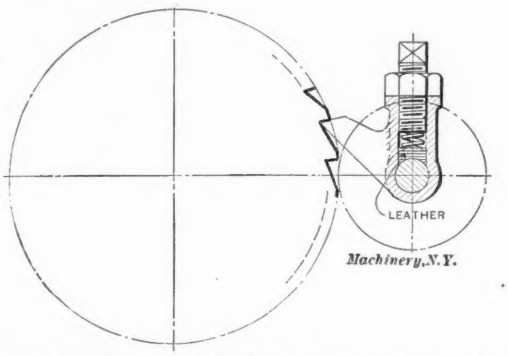


Fig. 14. Arrangement for Releasing Ratchet when Load is Lifted.

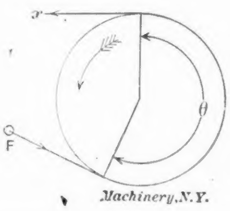
lowest possible coefficient of friction, it is always in excess of the reaction from the pinion at the radius to the center of the pressure of the frictional surface.

If r = radius of pitch circle of pinion = 6.2 inches,
W = load on teeth,
R = radius to center of pressure of disks = 8.7 inches,
p = pitch of thread,
μ = minimum possible coefficient of friction = 0.04,
N = number of frictional faces.

Then $\dfrac{W r}{R}$ must equal $\dfrac{N W \times 2 r \pi}{p} \times \mu$.

Take for example the brake shown in Fig. 12 and let it

TABLE VIII.



μ = coefficient of friction = 0.2 for iron to iron, 0.3 for wood to iron, 0.4 for leather to iron. P = pull on brake rim. x = strain on loose end of brake strap. F = strain on fast end. θ = arc embraced by strap (in degrees). Table gives tension on brake straps when $P = 1$.

θ	Value of x.			Value of F.		
	$\mu = 0.2$	$\mu = 0.3$	$\mu = 0.4$	$\mu = 0.2$	$\mu = 0.3$	$\mu = 0.4$
30°	9.09	5.89	4.29	10.09	6.89	5.29
45	5.89	3.76	2.71	6.89	4.76	3.71
60	4.29	2.71	1.92	5.29	3.71	2.92
75	3.35	2.08	1.45	4.35	3.08	2.45
90	2.71	1.66	1.14	3.71	2.66	2.14
105	2.26	1.37	0.93	3.26	2.37	1.93
120	1.92	1.14	0.77	2.92	2.14	1.77
135	1.66	0.98	0.64	2.66	1.98	1.64
150	1.45	0.84	0.54	2.45	1.84	1.54
165	1.29	0.73	0.47	2.29	1.73	1.47
180	1.14	0.64	0.40	2.14	1.64	1.40
195	1.03	0.56	0.35	2.03	1.56	1.35
210	0.93	0.50	0.30	1.93	1.50	1.30
240	0.76	0.40	0.23	1.76	1.40	1.23
270	0.64	0.32	0.18	1.64	1.32	1.18
300	0.54	0.26	0.14	1.54	1.26	1.14

be necessary to find the maximum safe load it will sustain at the pitch line of the pinion.

The maximum permissible pressure per square inch on the area of the two friction faces, to agree with a coefficient of friction of 0.04, is 600 pounds, which agrees with average practice.

The area of the two friction faces = 126.2 square inches.

Total resistance at center of pressure of faces = 126.2 × 600 × 0.04 = 3,029 pounds.

The reaction on the pinion teeth to correspond with this load $\dfrac{3{,}029 \times 8.7}{6.2} = 4{,}250$ pounds.

It has been shown above that the axial pressure required on the faces to sustain the load is 126.2 × 600 = 75,720 pounds, and having the load on the pitch line the purchase of the screw will have to equal $\dfrac{75{,}720}{4{,}250} = 17.8$.

The circumference of the pitch circle of the pinion is 19.6 inches, therefore the pitch of the screw will be $\dfrac{17.8}{19.6} = 0.9$, or, for practical purposes, 15/16-inch pitch.

Some arrangements must be adopted for the pawls in order to release the ratchet when the load is being lifted, otherwise an objectionable noise will be made. One common arrangement is shown in Fig. 14 in which there are two pawls, one of which is set at half the pitch of the ratchet and mounted on a shaft which is driven through light spur gearing from the brake shaft, as shown. The pawls are moved by this shaft through the friction due to the leather pads which are pressed onto the shaft by a spring.

Another, and somewhat simpler, construction is that shown in Fig. 15. In this arrangement the weighted pawl A is thrown in and out of gear by the hinged friction clips B,

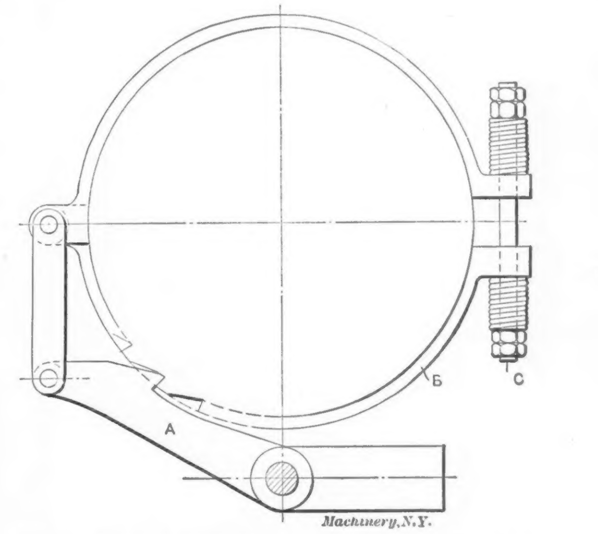


Fig. 15. Another Arrangement for Releasing Ratchet when Load is Lifted.

which are adjusted by means of the spring bolt C. In either of the above designs the pawls should always be so constructed that in the event of the friction drive failing they will fall into gear with the ratchet.

Shafts and Bearings.

Very little of more than a general nature can be said about the shafts and bearings for overhead cranes, since they possess no individual difference to those used for any other type of machinery. Although the calculation of the shafts is a simple matter in itself, it is no uncommon thing to find shafts stressed abnormally high, due to the fact that the size has been guessed at and not checked by calculation. A weak shaft is an annoyance, because, quite apart from the fact that breakage may take place, the deflection causes heating and binding and a consequent heavy loss of power. The forces due to the combined bending and torsion should always be considered in the ordinary way, and the diameters so proportioned that the stress does not exceed 6 tons per square inch for large shafts and axles, or 5 tons for small shafts.

No definite rule can be given for the limiting stress, it being rather a question of practical consideration and discretion. For example, if a heavy shaft is carrying its load near the bearing, it is safe to subject it to a stress that would not be permissible for a light shaft carrying a gear at some distance from the bearing, as for instance a shaft carrying a number of gears.

Overhung wheels should be avoided where possible, but where such have to be adopted the stress in the shaft ought

to be kept low, more especially if subjected to constant reversal, as for instance the pinion on the end of a motor shaft. Double keys placed at right angles are preferable for fastening gears on high speed reversing shafts.

Ordinary cast iron plummer blocks are generally used for steel-framed crabs, and should as far as possible be standardized, in order to permit manufacturing to stock. Bearings should be fitted with split brasses and adjustable caps where practicable, in order to allow of ready inspection and repair. One of the principal objections to the plate-sided crab lies in the fact that several of the shafts have to be carried in solid bearings. Large and substantial grease or oil lubricators should be fitted to all bearings.

The calculations and general details given above apply to all types of crabs, irrespective of the frame formation, or general design. The principal variations are in the type of brakes, due to the fact that certain makers have patents or particular designs of their own, the bulk of which are nevertheless only modifications of the two principal types mentioned.

The type of crab shown in Fig. 2 (January issue) which, it may be remarked, has only been shown for reference purposes, is subject to considerable modification when the number of ropes exceeds four, and it generally takes the form shown in the outline diagram Fig. 16.

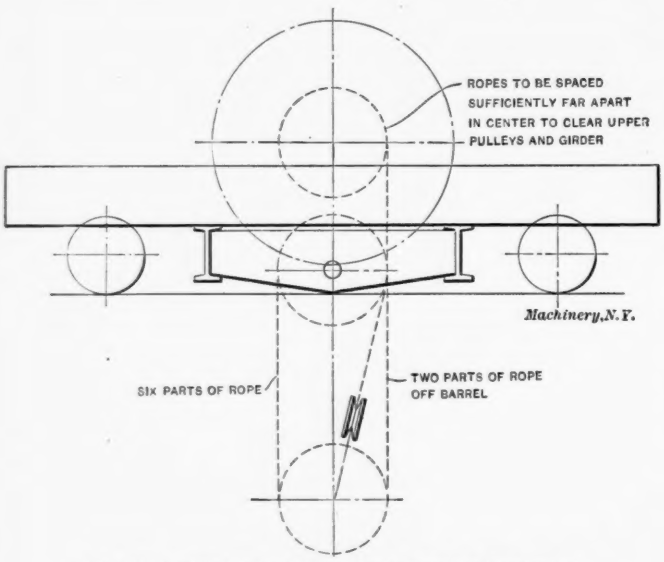


Fig. 16. Modification of Crane Crab when the Number of Ropes exceeds Four.

Many makers use four ropes for cranes up to 50 tons, six up to 75 tons and eight up to 100 tons, or in other words limit the load off the barrel to 25 tons, and these quantities may be taken as a maximum.

* * *

In a large watch factory there is a considerable force of men constantly employed, called "bug hunters," to discover obscure defects in watch movements, which have developed in the regular tests for time-keeping to which the movements are subjected. With any practicable system of inspection of jigs, fixtures and product, there will be, on work of so delicate a nature as a watch, certain parts passed which contain defects not discovered, and scarcely discoverable. When the movements are assembled containing such parts, the discovery of the cause of the irregularity in the time-keeping is not easy. The men detailed to inspect the defective movements and clear up the trouble belong to a peculiar class and have what might be called a sixth sense, which enables them to almost instantly, in the majority of cases, tell the cause, no matter how obscure. When once located, the remedy is easy. It is in the matter of location that the ability of these men lies, more than in their mechanical skill. It is difficult to account for this sense, because it cannot be consistently attributed to a latent sense of hearing, sight or feeling. In the case of large machinery defective operation will make itself known to the operator by sound, manipulation, or sight, but in the case of a delicate watch movement, these senses can be used to a limited extent only, to locate defects.

IMPROVEMENTS MADE BY MOTOR-DRIVEN TOOLS IN A REPAIR SHOP.

The illustrations, "before and after taking," strikingly show the improvement of conditions of a typical belt-driven repair shop and the same shop re-organized and re-arranged for motor-driven tools. The photographs were taken in the repair shop of Peter Doelger's Brewery, New York City, and Fig. 1 shows the shop as equipped just before the change. The machinery was driven by shafts, counter-shafts and belts, including right-angle transmission and mule pulleys. Fig. 2

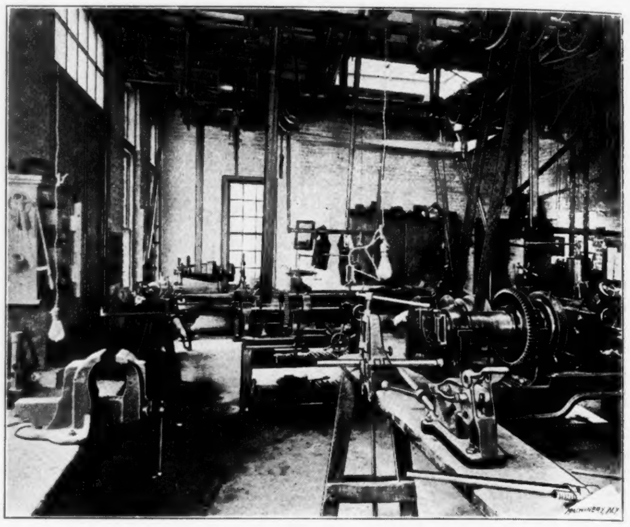


Fig. 1. Old Repair Shop in Peter Doelger's Brewery, showing Complications of Line-shafts, Counter-shafts, and Transmission Belts.

illustrates the same shop after the plant had been equipped throughout with motor-drive and two new motor-driven machines had been installed.

The shop now contains a 36 x 36-inch Hamilton planer, driven by a 5-horse-power motor, the motor running at 1,000 R. P. M.; 9-inch pipe threader, driven by a 5-horse-power 1,000 R. P. M. motor; 2-inch pipe threader, driven by a 1-horse-power 1,200 R. P. M. motor; drill press driven by a 2-horse-power 1,100 R. P. M. motor; 18-inch Hamilton lathe driven by a 4½-horse-power variable speed motor, having a speed range from 580 to 1,740 R. P. M.; and a small 1-horse-power portable saw.

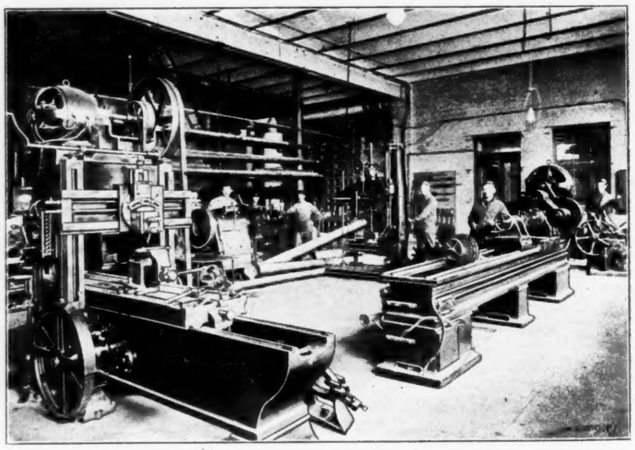


Fig. 2. Reorganized Repair Shop in Peter Doelger's Brewery, showing Motor-driven Machine Tools.

Neither the planer nor the 18-inch lathe were in the old shop, but even without these tools the transmission system was complicated. It will be noted in Fig. 1 that a quarter-turn belt and several reversing belts were necessary. The machines were much crowded, and it was impossible to handle work of considerable size, owing to lack of space. In the new shop the machines are arranged without reference to the line shaft or counter-shafts, being placed exactly where wanted and to facilitate the handling of the work. Each machine has plenty of space around it.

All the motors driving the various machines illustrated were built by the Crocker-Wheeler Co., Ampere, N. J., to whom we are indebted for the photographs and data.

SPECIAL TOOLS AND DEVICES FOR AUTOMOBILE FACTORIES.*

ETHAN VIALL.†

The shop practice at the factory of the E. R. Thomas Motor Co., Buffalo, N. Y., is equal to that of any other concern engaged in automobile work, although the growth of the concern has left it somewhat cramped for room. As in most shops, much of the work is done in the regular, or what might almost be called standard, way, but here and there are interesting, original or unusual devices that attract the attention of the mechanic.

One of the first things to attract the writer's notice was the device, shown in Fig. 1, for holding the rear axle while turning the spindles. The reason why these axles cannot be turned on centers, is that the spindles are not in line, but are bent at an angle in order to give the wheels the proper

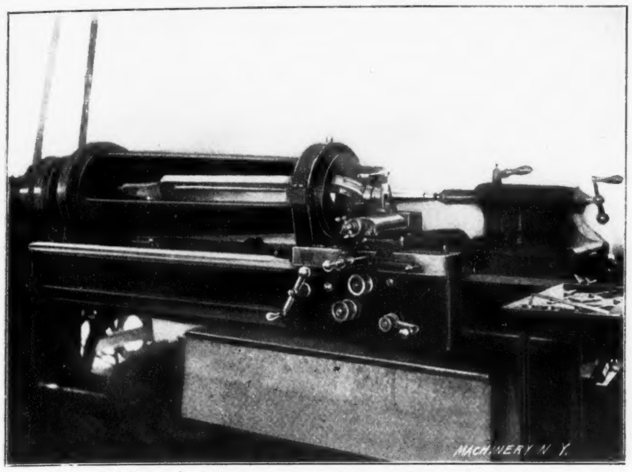


Fig. 1. Fixture for Holding Rear Axle while turning Spindles.

inclination when in place. In the fixture shown, the axle is bolted securely to the cross pieces in the long, slotted drum or sleeve in such a way that the spindle to be turned is in line with, and supported by, the tailstock center. With this arrangement the spindles are accurately machined in the least possible time. This device, as well as most of the other special tools, was designed and made by Lucien Haas, tool designer, and C. B. Buxton, assistant superintendent.

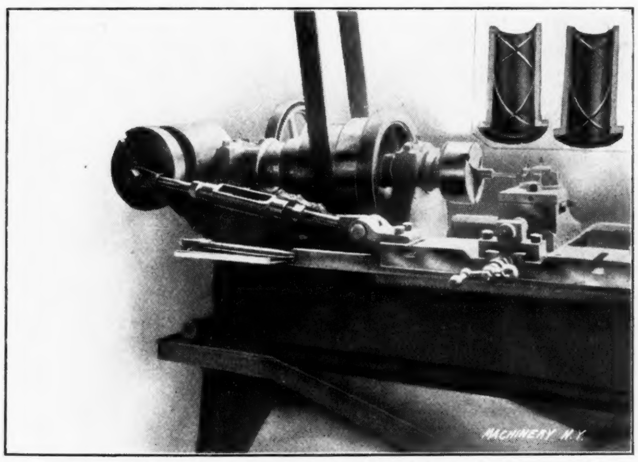


Fig. 2. Machine for Grooving the Inside of Brass Bushings, and Sample of the Work Done.

The cutting of oil grooves on the inside of brass bushings is a difficult problem, and until the machine shown in Fig. 2 was made, all brass bushings used in the construction of the Thomas machines were grooved by another firm, making a specialty of this work; but since the old lathe was made over as illustrated, the bushings have been both double- and single-grooved at less than one-fourth of the previous cost. In the upper right-hand corner of the half-tone, is shown a bushing which has been split in two in order to show the way in which the machine does its work. The principle of this simple, effective machine will be readily grasped by inspecting the illustration.

* See also MACHINERY, March, 1909, engineering edition: "Organization and Equipment of an Automobile Factory."

† Associate Editor of MACHINERY.

Another old lathe which has outlived its usefulness as such, and has been made into a special machine, is shown in Fig. 3. This machine is used for facing or counterboring various automobile parts, the old tailstock having been replaced by a special sliding stop operated by means of a hand-lever and

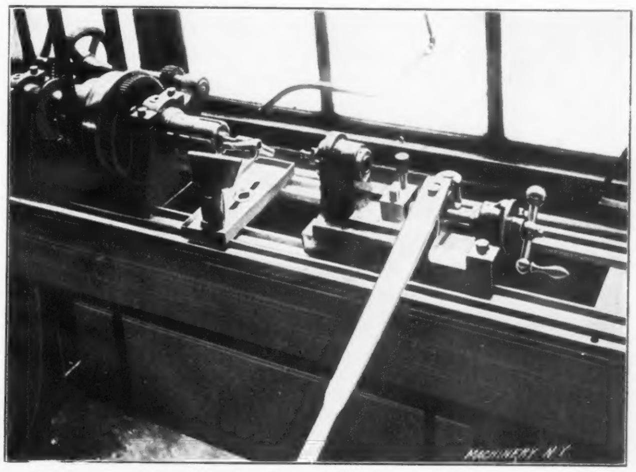


Fig. 3. Facing and Counterboring Machine, with Micrometer Stop.

accurately set by a micrometer screw adjustment; so that once set for a given stroke, any number of pieces may be machined exactly alike. The live spindle is fitted with a special chuck having a hardened and ground spring collet, and the shanks of all the counterbores and facing tools used in this machine are also hardened and ground in order to eliminate

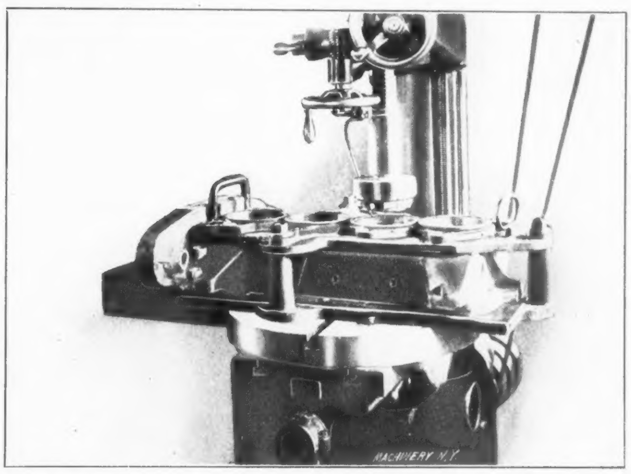


Fig. 4. Jig and Boring Tool for Boring out Cylinder Holes in Crank Case.

as much as possible the errors caused by warped or untrue shanks.

Fig. 4 shows the way the cylinder holes in the upper half of an aluminum four-cylinder crank-case are machined. The manner in which the boring tool cutters are guided in the jig bushings by the hardened and ground shoulder on the tool,

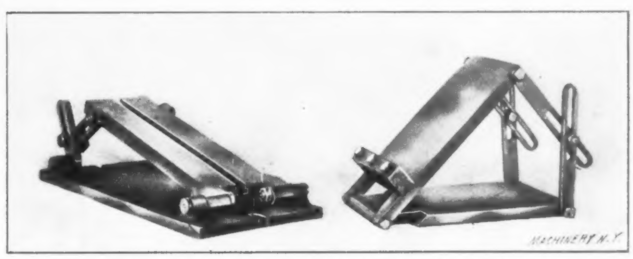


Fig. 5. Adjustable Angle-plates for Milling Machine and Drill Press.

is very plainly shown. Handles are placed on the top of the jig for convenience in handling, when putting it on or taking it off.

Toolroom Kinks.

In the toolroom are a number of interesting things, not the least of which are the adjustable angle plates for the lathe, drill-press and milling machine; those for the two last-named machines being shown in Fig. 5. In Fig. 6 are shown some special removable-pin racks for holding gangs of milling cut-

ters. As the illustration shows, the whole gang may be lifted off the board and taken to the milling machine without unnecessary handling of the individual cutters. The ends of the pins are drilled so that cotters may be inserted if wanted. This is the best scheme for keeping small gang mills together that the writer has ever seen.

Limit gages for inside work are made of heavy tubing with pins run through crosswise near the ends, as shown in Fig. 7. The method of writing the sizes of the gages on cards which hang close to them, is a good one, as it not only makes it easy, in the first place, to find the gage wanted, but also to replace it correctly after use. The size is, of course, stamped on the gage itself in the usual way, but as everyone knows who handles tools of this kind, the figures are too indistinct, even when rubbed with chalk, to be easily read. The holes for the pins in these gages, as well as the holes for the handles

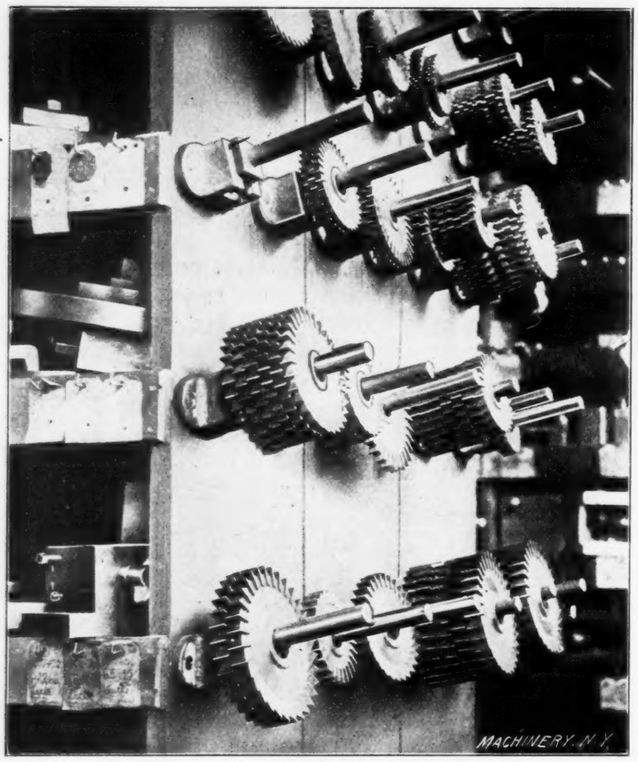


Fig. 6. Gang-mill Removable Storage Pins.

of all sizes of socket wrenches, are drilled in the jig shown in Fig. 8. This jig is an improvement over the usual jig of this character and Mr. Haas has so designed it that it will center accurately and hold firmly anything that will go through the hole in the clamping-slide which carries the drill bushing, three sizes of which are shown. These drill bushings

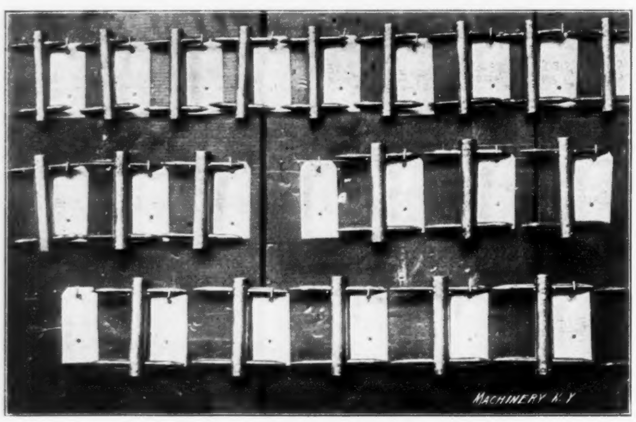


Fig. 7. Cheap Limit Gages with Size Cards.

are hardened and ground and then lapped to fit the stationary bushing in the clamping-slide. The knurled nut that draws the slide down onto the piece to be drilled has a coarse thread and, after the jig is set for any particular size, a pin placed in one of the holes in the nut makes a very effective locking-lever, as a quarter turn will tighten or loosen the clamp.

The tool-chart shown in Fig. 10, a copy of which is kept in the various departments, enables the different foremen to order exactly the tools wanted, and also makes it easy to keep up the supply in the tool storage bins, for as soon as the tools

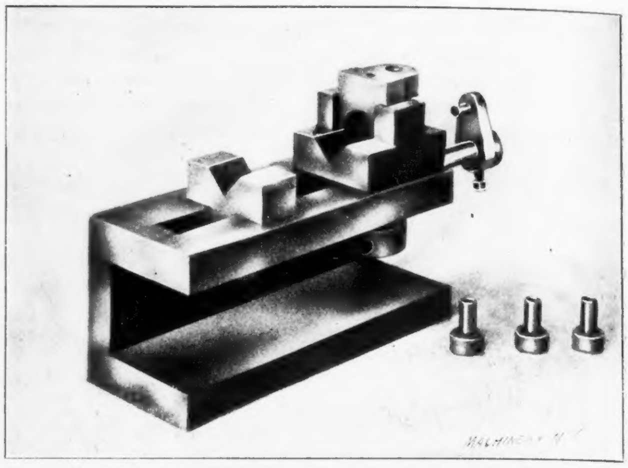


Fig. 8. Jig for Holding Round Bar Stock while drilling Cross-hole.

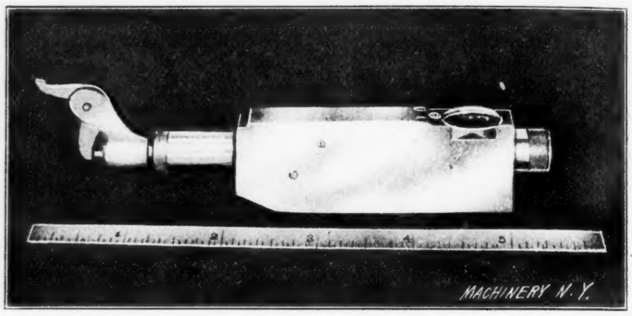


Fig. 9. Home-made Dial Indicator.

of any type begin to run out an order for a new supply of that particular kind is given to the blacksmith foreman, who refers to his chart and makes up the tools wanted as soon as possible.

Fig. 9 shows an indicator made by Mr. Buxton when he was working as a toolmaker ten or twelve years ago; the dial

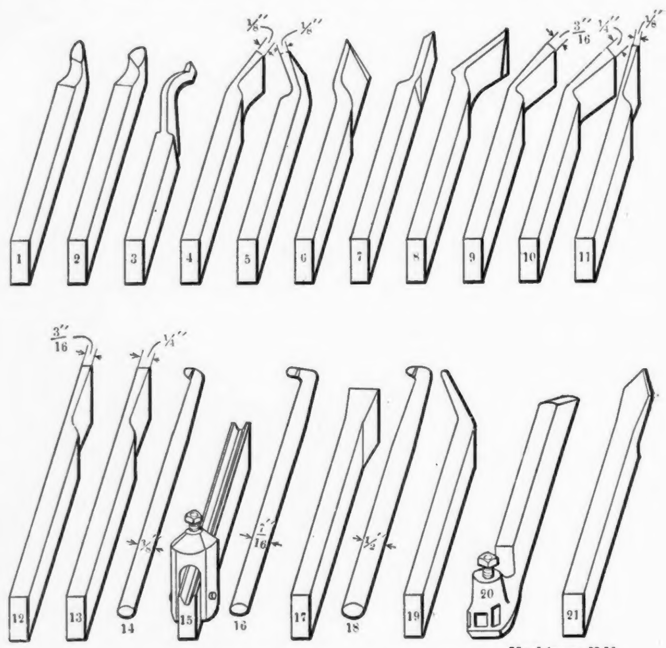


Fig. 10. Chart of Standard Lathe Tools which are ordered by Number.

is about $\frac{5}{8}$ inch in diameter and the whole device is less than $5\frac{1}{2}$ inches in length, as shown by comparison with the 6-inch scale in front of it.

* * *

During 1908 15,413 automobiles were registered in New York State, this being an increase of 1,446 over the number registered the previous year.

SAFETY VALVES.

At the meeting of the American Society of Mechanical Engineers, February 23, a paper on Safety Valves was presented by Mr. Frederic M. Whyte of the New York Central Railroad. In the opinion of the author, the engineering profession in general has been somewhat ignorant of the principles of safety valves, their relative capacity, and the capacities required for various conditions of steam generation. In marine work, certain formulas have been devised for calculating the sizes of safety valves, which have been more or less blindly accepted; but in locomotive work even a greater uncertainty prevails, although there is promise that the present unsatisfactory condition may be improved. The general practice in locomotive work has been to determine in an off-hand way the size and number of safety valves to be used, and former practice has entirely guided the designer. The capacity of the valve has been indicated in an unsatisfactory manner, being expressed as a "size," meaning the diameter of something more or less uncertain, while the other dimension, the lift, which is necessary to give an indication of the capacity, has been entirely ignored. It should be remembered that to know even the capacity of available valves is not sufficient; the important factor is to know how much steam is to be released, and in what length of time it should be released. In view of these various factors the suggestion was made by the author of the paper that instead of indicating the capacity of a valve in a rough way, by the diameter of some opening, the method be adopted of expressing the capacity in pounds of steam at certain pressures.

Another important factor in safety valves is the reliability of the spring, and the effect of the heat upon it. It should be possible to make adjustment easily, and at the same time the valve parts should be so arranged that it would be practically impossible for the valve to get out of adjustment.

On the question of the relation of valve capacity to steam generating capacity, the fact should not be ignored that in locomotive work the total valve capacity has not in the past been made as great as the maximum steam generating capacity, and this may be considered as ample proof that so great a valve capacity is not necessary. The reason for this is, of course, that on account of using the exhaust steam for producing the forced draft, when the demand for steam from the boiler is reduced or entirely cut off, the forced draft is also automatically reduced or cut off, and the generating capacity is reduced so that it is not necessary that the safety valve release the full generating capacity. Probably it is largely a question of opinion what percentage of the total generating capacity the valve ought to provide for, but it is likely that if attention is centered on this question, some fairly definite solution may result. The author concluded the paper by inviting discussion of these particular subjects in relation to safety valves.

During the discussion of the paper many different views were expressed. Mr. Philip G. Darling, of Manning, Maxwell & Moore, who has for two years past conducted extensive experiments on safety valves, presented a contribution, illustrated with lantern slides, on Safety Valve Capacity. He started from the premises that safety valves must have a relieving capacity at least equal to the boiler evaporation, as otherwise the boiler pressure will continue to rise, although the valve is blowing. Thus, with the exception of mechanical reliability, the most important factor in a safety valve is its capacity. Mr. Darling then proceeded to show an apparatus and describe the methods employed for determining safety valve lifts; he gave the results of tests made with this apparatus upon different valves, analyzed a few of the existing rules governing valve sizes, and finally proposed a definite rule, giving the results of the tests on which it is based.

Two factors in a safety valve geometrically determine the area of discharge and hence the relieving capacity: the diameter of the inlet opening at the seat and the valve lift. The former is the nominal valve size, the latter is the amount the valve disk lifts vertically from the seat when in action. In calculating the size of valves to be placed on boilers, rules, which do not include a term for this valve lift, or an equivalent, such as a term for the *effective* area of discharge, assume, in their derivation, a lift for each size valve. Nearly all existing rules and formulas are of this kind, rating all valves of a given nominal size as of the same capacity.

To find what lifts standard make valves actually have in practice and thus test the truth or error of the assumption that they are approximately the same for the same size valve, an apparatus was devised and tests upon different makes of valves conducted. With this apparatus the valve lift can be read to thousandths of an inch at any moment, and an exact permanent record of the lift during the blowing of the valve is obtained which is somewhat similar to a steam engine indicator card in appearance, and of a quite similar use and value in analyzing the action of the valve.

A portion of this apparatus, showing the safety valve and the gage for reading off the valve lift, is illustrated in the accompanying engraving, Fig. 1. The valve, during tests, is mounted on the boiler in the regular manner, and a small rod is tapped into the top end of its spindle; this rod connects the lifting parts of the valve directly with a circular micrometer gage, the reading hand of which indicates the lift upon a large circular scale or dial. The rod through this gage is solid and continues upward, maintaining a direct

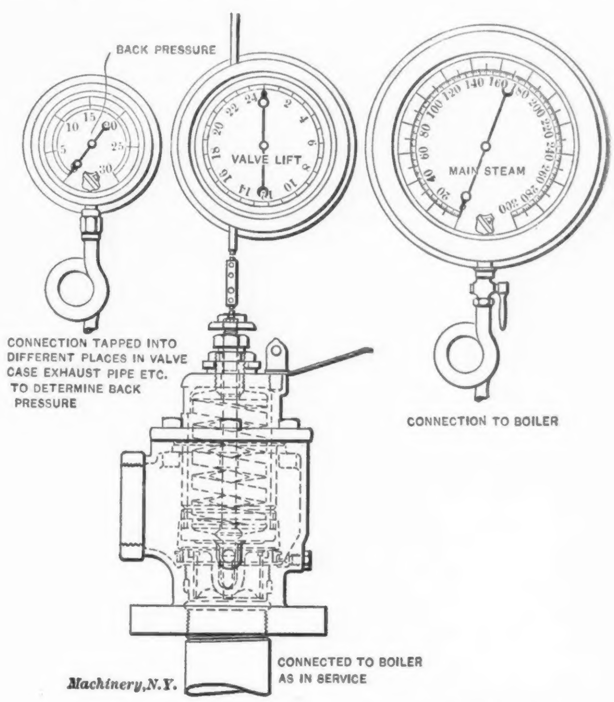


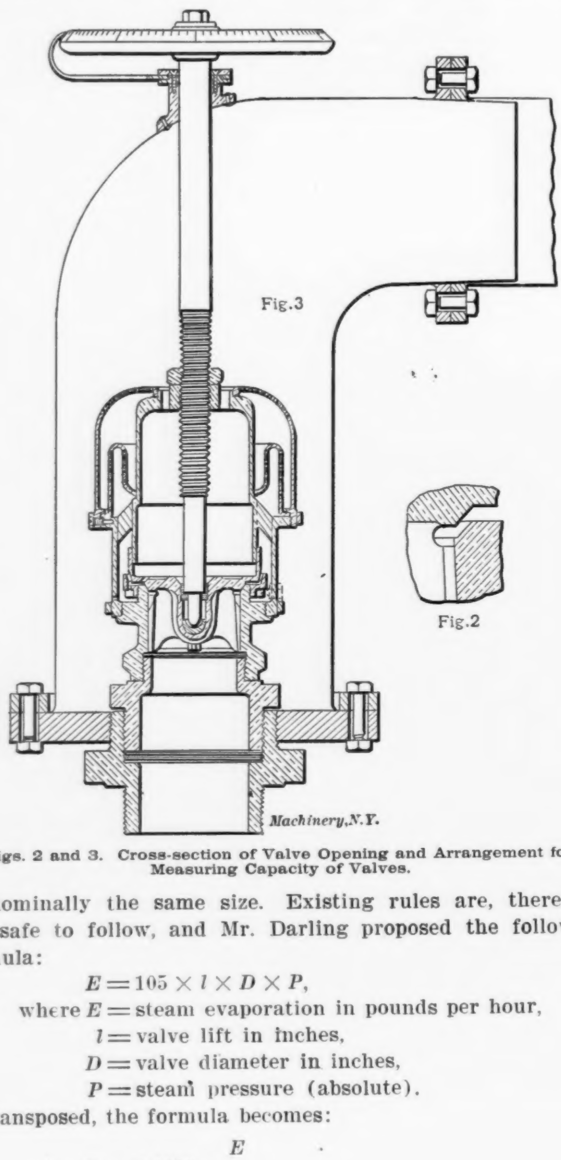
Fig. 1. Apparatus used in Tests for Determining Valve Lifts.

connection to the pencil movement of the recording gage above it, previously referred to. The experiments undertaken showed that with the exception of a small preliminary simmer, which some of the valves have, they open abruptly to a full lift, and close almost as abruptly when a certain lower lift is reached. Different makes of valves of the same nominal size are of greatly different capacity. Of seven 4-inch stationary safety valves, the lowest lift at the opening was 0.031 inch, and the highest 0.137 inch, while the lowest lift at the closing was 0.017 inch, and the highest 0.088; of six 3½-inch muffler locomotive valves tested, the lowest lift was 0.040, and the highest, 0.140 inch at the opening; while the lowest lift was 0.023 inch and the highest 0.102 inch at the closing.

The valves tested all had 45-degree bevel seats. The four wings of the valve probably reduce the flow slightly from what it would be if the theoretical area of opening is calculated, but as the wings are cut away at the seat, as shown in Fig. 2, a definite correction of the existing areas is impossible.

"The great variation—300 per cent—in the lifts of these standard valves of the same size," said Mr. Darling, "is startling, and its real significance is apparent when it is realized that under existing official safety valve rules, these valves, some of them with less than one-third the lift and capacity of others, receive the *same* rating and are listed as of equal relieving value."

That the lift of a safety valve is the true measure of its capacity, other things being equal, has long been recognized. As early as in 1875, a committee reporting to the U. S. Board of Supervising Inspectors stated as the result of its investigations that the diameter of a safety valve is not an infallible test of its efficiency, but that the lift which can be obtained in a safety valve, other conditions being equal, *is* the test of its efficiency. The rules followed in safety valve design, have not, however, taken full cognizance of this, and the result is shown by the variation in capacity of valves



Figs. 2 and 3. Cross-section of Valve Opening and Arrangement for Measuring Capacity of Valves.

of nominally the same size. Existing rules are, therefore, not safe to follow, and Mr. Darling proposed the following formula:

$$E = 105 \times l \times D \times P,$$

where E = steam evaporation in pounds per hour,
l = valve lift in inches,
D = valve diameter in inches,
P = steam pressure (absolute).

Transposed, the formula becomes:

$$D = 0.0095 \frac{E}{l \times P}$$

Modifications are given for locomotive practice, where,

$$D = 0.055 \frac{H}{l \times P}$$

in which H = total heating surface in square feet.

For cylindrical multi-tubular, vertical and water tube stationary boilers the formula becomes

$$D = 0.068 \frac{H}{l \times P},$$

and for water tube marine and Scotch marine boilers

$$D = 0.095 \frac{H}{l \times P}.$$

In order to determine the constant or coefficient of flow at different lifts and how it is affected by variation in valve design and adjustment, an extended series of tests was recently undertaken at the Stirling boiler department of the Babcock & Wilcox Co. at Barberton, Ohio. The feed water of the boiler was measured, and the entire steam discharge of the boiler was through the valves being tested. The valves were all previously tested and adjusted on steam; and without changing the position of the valve disk and ring, the springs of these valves were removed and solid threaded spindles inserted, as shown in Fig. 3. At the top of these spindles a graduated disk was placed, by means of which the lift could be exactly determined.

Mr. Albert C. Ashton of the Ashton Valve Co., stated that it did not seem to him that what is most needed to-day is valves of greater capacity, "but rather a better understanding of the proper proportioning of safety valves to boilers, for which no universal rule has been recognized and adopted." He stated that high-lift valves, under some circumstances, may even be considered dangerous, and if high-lift valves were a decided improvement over the best standard makes, manufacturers of safety valves could easily change their design to make nothing but high lift valves; generally speaking, a lift of 1/8 inch is excessive, though valves with a lift a little higher than the standard, say 1/16 inch, would have some advantages.

A presentation of the subject of safety valves, as it appears to the locomotive builder, was contributed by Mr. F. J. Cole of the American Locomotive Company; he referred to the practice both in this country and abroad, and cited several reasons in explanation of the apparent disregard of definite rules governing the application of safety valves to locomotives

Mr. Garland P. Robinson, State Inspector of locomotives, referred to the fact that his experience indicated that no rule is generally followed in determining the size of safety valves for locomotive boilers; he believed that a formula based on the heating surface and providing for 50 per cent of the maximum evaporation of the boiler would give satisfactory results for locomotives. Using the notation above, he gave the formula (applicable to locomotives):

$$D = 0.05 \frac{H}{l \times P}$$

In view of the fact that some of the tests referred to in the discussion have been conducted by manufacturers of valves themselves, Mr. Carhart, of the Crosby Steam Gage & Valve Co., emphasized that "the actual lift or discharge area of valves should be determined and reported upon after impartial tests conducted by competent and disinterested engineers, * * * and not from reports of tests conducted by any one manufacturer without the knowledge of other makers whose valves are tested, and where the one measurement noted has been, in many cases, purposely limited by the manufacturer for special reasons."

* * *

HORSE-POWER REQUIRED FOR MOVING CARS.*

MORRIS A. HALL.

It is a rather complicated problem to determine the power required to move a railroad car of known weight at any known speed over a level track, or up a known grade. A diagram, or graphical chart, however, can be prepared, from which the power required may be obtained practically at a glance if the quantities, speed, weight and grade be known. Such a diagram is presented in the accompanying Supplement. Suppose, for an example, that the car weighs 15 tons, or 30,000 pounds, and assume further that we wish to move this car at a speed of 25 miles per hour over a level track. Find first on the right-hand vertical scale the point marked 15 tons (the weight of the car), and follow the horizontal line from this point to the intersection with the oblique line marked 25 miles per hour and from this intersection follow a vertical line downward intersecting the horse-power scale for level track at 30½ H. P. Suppose that the car must also climb a grade of 3 per cent somewhere on the line. In order to find the horse-power required for this, follow the same vertical line, already found, until it intersects the oblique grade line marked 3 per cent grade, and then follow the horizontal line from this intersection point to the right-hand vertical scale, where we find the required power for climbing the grade to be 93 H. P. As will be seen, the diagram can be used for cars weighing up to 20 tons, for speeds from 3 to 30 miles per hour, and for grades from 1 to 10 per cent.

* With Data Sheet Supplement.

DESIGN AND CONSTRUCTION OF METAL-WORKING SHOPS—6.

CONSTRUCTION PERIOD.

WILLIAM P. SARGENT.*

The previous articles of this series have covered the engineering work in connection with the planning and developing of projects of plant improvement from the conception of the idea to the beginning of the actual work of construction. At the beginning of the construction period the engineering control of the project takes on the function of supervision, and if this supervising is not efficient the best and most thorough planning will be fruitless as far as obtaining a high degree of excellence of construction and the completion of the project on the predetermined date is concerned.

Miscellaneous Notes on Construction Work.

Many of the following commentaries may belong more properly to the planning of the work, but they are brought to mind by the consideration of the construction period, and therefore are presented in connection with the discussion of the carrying out of the plans.

The good-will and personal regard of the contractor and his foremen for the engineer in charge of construction work is a stronger factor in securing good work than the strictest supervision and inspection. This holds true in general with the building trades, but one cannot go to an extreme in guarding against unintentional errors and omissions in the laying out of the main working lines of a project and other points that cannot be remedied easily and cheaply. A contractor loses profit and an owner loses time when slips occur in the early part of building operations, so this part of an engineer's care is very important.

Oftentimes such work as trackage, sewers, power-house, water supply, etc., cannot be laid out and contracted for satisfactorily in advance of the awarding of contracts for the buildings. It is then necessary to organize a working force controlled directly by the engineer in charge or by a foreman who receives instructions from, and reports to, the engineer. The writer, in a general way, would advocate that all work should be done by outside contractors, under specifications, whenever possible to plan ahead and give definite directions. If the concern is of such a size as to have at all times on its payroll men of the various building trades, such as masons, carpenters, yard-men and others who will be responsible for the repairs on the new plant in the future, it is advisable to handle all underground work directly. By adding to the plumbing force, for instance, the sewer work can be done cheaper and better in this way, and the head plumber not only has the opportunity to familiarize himself with the drawings, but also sees the work go in, and he cannot afterwards lay the blame for avoidable troubles onto anyone but himself. In the sewer work, for example, changes will often be necessary in the layout almost as soon as work is started, on account of surface drainage or draining excavations. A site is selected because of its being level, but surface water cannot be carried away by means of open ditches without interfering with the rapid transfer of materials, and it pays well to keep the site dry and avoid the seas of mud so often in evidence about new buildings. Then again, tees and other branches can be placed wherever there is the possibility of future need and their location noted on the blueprints, and afterwards on the record drawings, if the work is done by the owners. With a contractor doing work so liable to changes, bills for extras are sure to result, and furthermore the additions and changes will seldom be followed up and recorded on the drawings.

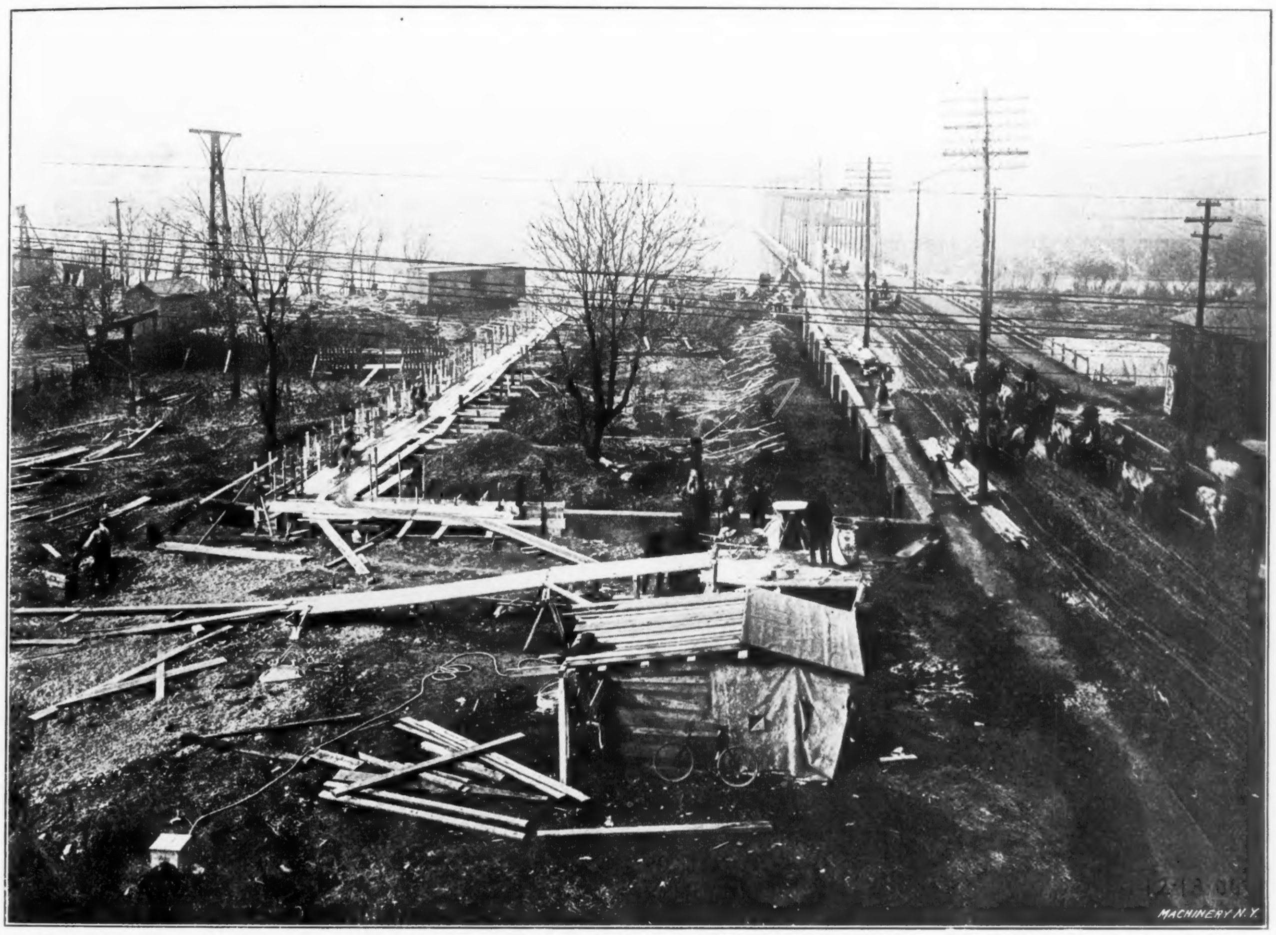


Fig. 37. A Job on which the Contractor put in a Bill for 1,000 Extra Cubic Yards of Excavation. The Photograph Helped to settle the Bill for Something like 100 Yards.

The importance of inserting extra branches at intervals should not be passed over lightly, as the labor required to either cut a hole in tile pipe or set in branches by means of sleeves will pay for these extra branches a dozen times over. Holes can be cut in tile pipe when the pipes are hard rammed full of sand and the pipe is on the ground, but the difficulties arising from the necessity of doing this cutting at the bottom of a trench and with the sewer running nearly full can well be imagined. The branches should be carried up to within two or three feet of the floor level and have

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plugs inserted. It is also a wise precaution to cover these plugged ends with a close woven fabric as soon as possible to prevent building debris from getting in and clogging the pipes. In every case it is advisable to use cast-iron soil pipe within the walls of the buildings, and in the vertical branches wherever there is a probability of excavating and damaging the pipes. All branches for future use should be marked by setting a stake and they should be located definitely on the record drawings. If branches must be set in a line of finished tile sewer, the split tile mentioned in a previous article of this series should be used, as a section of straight pipe can be broken out and the lower half of the new branch rocked into place and cemented and inspected before closing in with the top half.

The main runs of pipe should invariably be made large enough to provide for the extension of the plant buildings.

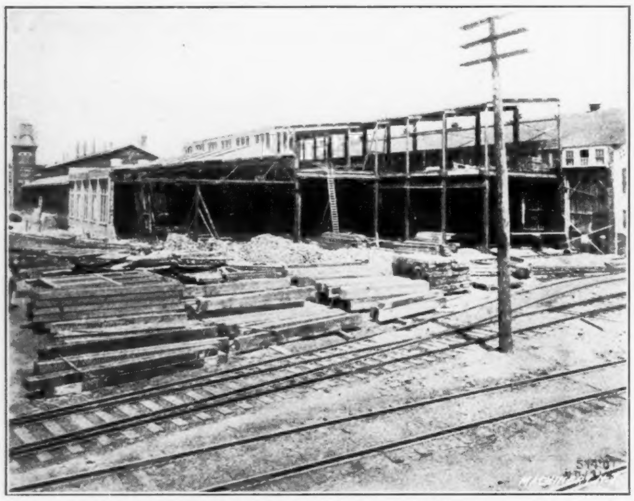


Fig. 38. Shop Construction held up in the Condition shown for nearly Two Months because of Lack of Railway Trackage.

The end of every run of pipe, either main or branch, should finish either with a curve of long radius or with a manhole to permit of flushing with a hose or starting obstructions by means of wires.

Grades of Sewers.

There is any amount of information extant concerning the proper amount of fall that should be allowed for sewers, but very little that will help in determining the *very least* that can be used. The problem is often whether the slope that can be easily obtained is sufficient or not. Nearly every engineer has to depart from the recommended practice at times, and precedents are then more valuable than theory. There was a description of a sewerage system in the *Engineering News* of February 6, 1906, in which the slope was given as one-tenth of 1 per cent or approximately 5 feet per mile for an 18-inch sewer; and about 4 feet of head was all obtainable with this slope, and this head had to operate a septic system. A septic system will be a necessary part of nearly every large plant built in the future, as the pollution of streams will not be tolerated. Many of the large railroad shops have septic systems, and one large industrial plant saved over $1,800 per year on its water bill by such an installation. The cost of a septic tank and filters approximates $5.00 per man. The above mentioned article is one of the most concise descriptions of a septic system published.

The predetermined slope of a pipe sewer can easily be obtained in construction by excavating nearly to the desired depth and driving stakes. The tops of the stakes represent the undisturbed bottom of the trench and should be set with an instrument. The bottom can be graded to the stakes, and by digging out for the bells of the pipe, the barrel of the pipe rests on solid ground. *Salt glazed* tile should always be used to secure strength and freedom from porosity.

In making layouts of sewers, a small scale is naturally used and the details of branches, etc., are often too small to be well shown. A method of numbering the branches and giving data of lengths, sizes, location of traps, in marginal notes similarly numbered is recommended. The branches on one side of the main line should be numbered odd and on the other side numbered even, beginning at one end of the system. This method of numbering aids in listing material and checking off the work as finished.

Drainage of Pipe Tunnels and Basements.

It is seldom possible to lay drains for underground chambers and tunnels that will clear them of seepage water by a gravity flow. It is hardly possible to thoroughly waterproof the side walls of concrete without excessive cost for excavating to afford room for men to work between the sheeting and the wall after the forms are struck. For these two reasons, sump pits should be installed below the floor level, and steam syphons or other forms of pumps put in to raise the water to the level of the gravity drainage system. There are a number of compounds on the market which are intended to be mixed with the cement to prevent seepage. These have been efficacious in some instances, but failures have occurred that suggest the advisability of providing for the removal of seepage, even if a compound is used.

Whitewashing of the interior wall surfaces should be deferred until either seepage is evident or a certainty of a dry chamber is assured. One very good way to handle seepage is to localize the leakage by drilling holes in the walls at the points of greatest leakage, and by means of small pipes laid in channels cut in the concrete, leading the water to the drain and sump. Porous agricultural tile laid outside the wall near the bottom will often take care of the surface drainage and prevent seepage, and such tile should be laid even when the interior drains and sumps are provided. The roofs of tunnels are generally waterproofed with a multi-ply felt roofing laid with pitch as on buildings.

There is one most important point in planning pipe tunnels that is often neglected—the exact location of branches of piping which cross over and lead into buildings. It is often necessary to carry a branch back of the interior wall line, then up and through a raised chamber, in order not to unduly restrict the free opening of the tunnel. As these recesses cannot be put in after the tunnel is built it is obvious that most careful study and laying-out of the piping should be done before making the final drawings of the tunnel.

Wrought Iron Piping.

The use of galvanized pipe where laid unprotected underground is strongly advocated. The deterioration of black

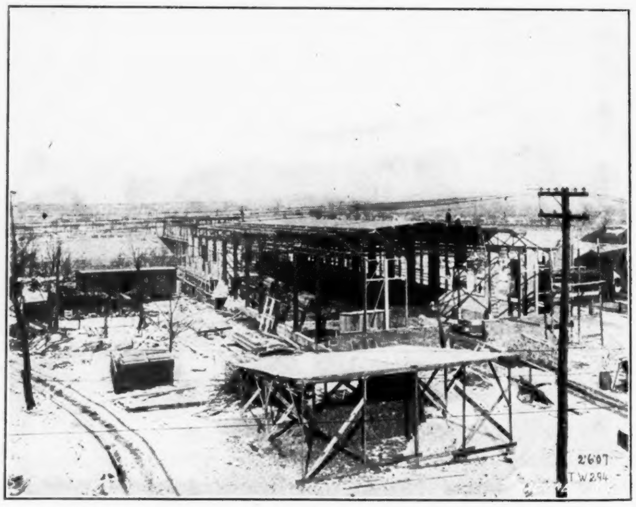


Fig. 39. An Illustration of the Opportunity for carrying on Work inside when Masons work on Outside Scaffolds.

pipe has been noted by nearly every engineer who has watched excavation around old buildings, and the recommendation of galvanized pipe made here is based on the experience of an old engineer in the Middle West, whose work for nearly 40 years had been mainly in connection with pumps and water-works. This same engineer has noted the deterioration of black pipe when used inside of shops for compressed air and states that galvanized pipe has a much longer life than black pipe when used for this purpose.

Concrete Work.

Great stress is often placed on the testing of cements and concretes irrespective of the nature of the work. It is hardly practical to specify a different mixture for each par-

ticular mass of concrete, so an experienced foreman is apt to judge the concrete by the color and to vary the mixture according to the need for a rich or lean mixture. It would be unwise to arouse the antagonism of the construction foreman by insisting on a rigid compliance with the specifications for the "mix" for concrete to go in the bottom of masses and in unreinforced members on which there is little load.

Let the foreman know that the concrete will be tested with a pick after the forms are struck and the concrete is set and aged, and that defective work must then he replaced. It will not then be necessary to place a watch over the mixer, for if the foreman is competent the quality of the work will be satisfactory even if the contractor does save a few dollars.

There is a great difference of opinion as to the effect of freezing on concrete. Nobody maintains, however, that freezing helps concrete, and concrete which has been frozen and can be broken with the toe of one's shoe is certainly unfit for anything. It is believed generally that concrete can be safely put in at any temperature as long as it is protected from freezing by means of hay, straw, etc., until it has set. The writer is informed by an engineer of the Pennsylvania R. R. that concrete has been put in at zero temperature without any freezing. The following rule is believed to be safe for the permissible minimum temperatures: Concrete may be put in down to 35 degrees with a falling thermometer and at 28 degrees with a rising thermometer.

Many methods and expedients are used in the attempt to obtain a good surface on concrete. Even if the surface is to be bush-hammered afterwards it is the better if made as uniform as possible when being placed. The thin-edged square-end spade so often recommended does not always force the aggregate back sufficiently, and paddles of wood ½ inch or more thick are better. The proper thickness can be found by watching the effect on a section from which a form board can be removed. Of course, tongued and grooved lumber will make a better surface than plain boards. Nothing less than 2-inch plank, with uprights on a 2-foot center, should

Fig. 40. Inside of Shop shown in Fig. 42, during Construction.

be used in order to prevent bulging. With the uprights on 2-foot centers, stock lengths of lumber can be used without waste.

It is difficult to obtain a uniform level for the tops of piers and pilasters where columns are to be set. This cannot be done by attempting to flow the concrete to a line. It is better to keep the concrete an inch or more below the line and build up to the line with a rich cement mortar trowelled on. The common way of levelling up columns is to grout in under the column footplates, pushing the grout in with a paddle. This does not, with any degree of certainty, provide an even bearing on the concrete. The best way is to leave 2-inch holes in the footplates and pour the grout in until it shows all around the plate, confining the grout with a dam of clay or putty.

It is obvious that the forms for foundation walls will not be built on the entire outline of the building at once, but that sections of concrete will be put in up to the floor level and the forms then built up for the next section, using the lumber from the completed section as fast as the forms can be struck. This necessitates vertical joints. These stop-offs will not do material harm if the old and new sections are bonded securely. Undoubtedly the strongest and best method is to use steel reinforcement, letting the steel run into both sections about 2 feet.

The "V" joint commonly used has but little strength, as dependence is placed upon cohesion alone. A square tongue and grooved joint is stronger in both directions. The "V" joint often leaves an unsightly fissure in the face of the wall at the feather edge. If either joint is used to take care of strains in the direction perpendicular to the wall, reinforcement should be invariably used in addition. The surface of all parts of older work should be scratch-brushed before placing fresh concrete. Many contractors content themselves with washing the surface with a little water or throwing on a little dry cement. Reports of recent tests indicate the ad-

Fig. 41. Inside of Same Shop as shown in Fig. 40, at a Later Period of Construction.

visability of cleaning and scratching and brushing with a cement grout.

A frequent cause of differences between the engineer and the contractor is extra concrete and excavation. It is very easy to avoid trouble on this score by having the bottoms level, the footings uniform in thickness and then taking measurements from the top of the wall to the footings after striking the forms. These measurements should be taken by the engineer and a representative of the contractor jointly. Records of these measurements should be made in duplicate and signed by both parties. This precaution will tend towards amicable relations.

Fig. 37 shows a job on which the contractor put in a bill for 1,000 extra yards of excavation. On account of measurements taken as above, and the photograph, this bill was settled for, within five minutes, on a basis of something like 100 yards, and the contractor was satisfied.

Grading and Filling.

For filling in the deeper portions of holes, almost any material will do; but as the floor level is approached care must be exercised to get the material so placed that the voids in the coarser material will be filled by the fine dirt, which is best done by using water from a fire hose. Twenty-five dollars worth of water will accomplish more than a hundred dollars expended for tamping. Ashes, cinders and gravel are all good for filling for the inside of buildings, and in some sections of the country locomotive front-end cinders are used as a substitute for concrete. This does not make such a solid floor as concrete but is all right for subsidiary buildings. The filling inside of buildings which are to have other than dirt floors, should be started as early as possible, so that low spots may be discovered and filled, and thus a firm substructure for the concrete secured. When grading for future trackage, make certain that the surface is kept low, as it is difficult to depress a track. Section men will often raise a relatively long stretch of track rather than depress a short length.

Track Work around Industrial Works.

In the following notes it is assumed that it is permissible in putting in track work for a large private plant to consider the factor of future repairs as very important, and that a first cost is justified which is greater than often expended for private corporation trackage.

Ballast should be at least 8 inches deep under the ties. The ties should be 6 x 8 or 7 x 9 inches, and may be spaced on 24-inch centers to make a solid track. With a regular spacing of 24 inches on straight track, the spacing will be about 19 inches at the mouth of the frog, and about 22 inches at the points of 15-foot switches and decrease to 19 inches at the heels. Tie plates will add about 15 cents per lineal foot of track, but they will lengthen the life of the ties 50 per cent. A 70-pound rail is probably the most economical section to use about a plant building heavy machine tools or large engines, because of the heavy switching. Such a rail will last longer than a 60-pound rail or the "re-lay" rails which are generally used. The first wear of a rail is well worth the added cost over old rails.

Fig. 42. Outside of Shop Illustrated in Figs. 40 and 41.

Suspended joints should always be used, and angle plates rather than fish-plates. The "pumping" of a tie at a supported joint is certain to cause excessive wear of the rail ends and to make low spots in the track. In laying out tracks remember that railroads are often "sticklers" about any track over which they may be called upon to operate, and even if the works is to do its own switching the curves and grades should be such that a railroad cannot consistently refuse to operate in the event of a private switch engine being laid up for repairs. The Inter-State Commerce Commission has recently established a minimum permissible curvature of 175 feet radius and a standard frog can be obtained for this curve. A 1 per cent grade should not be exceeded on curves if a small engine is to be used. Low switch-stands with targets cost more than the common ground-throw type, but are much better, as dependence is not entirely upon signals given by a brakeman.

The ideal curve for turn-outs or cross-overs would be one that would give a uniformly accelerated motion in the direction of departure from the principal track. If the frog and switch are made with straight rails and start with an angle less than is generally called for by the curve, an approximation to the ideal curve will be secured. This method starts the curve easy and the radius is gradually shortened as the curve advances.

The gage of the track should be standard except on curves, and even for the 175 foot radius curve a widening to 4 feet 9 inches is sufficient. In laying out curves that lead into buildings, see that the curve does not begin for nearly a car-length outside of the door. This permits of narrower doors than if the curve starts at the wall line. For side clearance on straight track keep all obstructions 6 feet 6 inches away from the center of the track. The safest way to check for interferences on curves is to make a dummy of a 40 foot car to scale, cutting the corners back on one side to the kingbolt centers. Move the dummy around, keeping the kingbolt centers on the track center line and watch the corners and side for interference with buildings or other obstructions. Keep obstacles at least 4 feet away from the side or corner of the car. Very substantial bumpers of a type that is secured to the rail should be put up at the ends of all tracks. A "Y" in some part of the track system is necessary in order that the switch engine can be turned end for end once every week or two. This distributes the wear over the wheel flanges on both sides of the engine.

As much as possible of the track system should be put in in advance of the building operations to expedite the placing and unloading of material. This will be appreciated by the contractors, and as the tracks have to go in some time, it is as well to get the use of them when time can be saved that will help to get the plant running earlier. The track scales should be put in at the start, especially if the steel work is to be paid for on a tonnage basis. The weights of the bills-of-lading may be right; but if the project is of the size of the model plant previously described, the amounts in question are great enough to warrant extra endeavors to provide a means for securing correct weights.

Fig. 38 shows a building which was held up in the condition shown for nearly two months because of the delay in the track work being done by a railroad company.

Erection of Structural Work.

The unloading of the first car of steel work will indicate for the time being whether or not the fabricating company is really making an effort to erect the material on time. If the first car-loads are made up of columns for the first building wanted, well and good; but if they consist of members for buildings not wanted until later, then a "loud holler" must be made. The securing of material in the proper order is a point where the inspector at the shop can be of great value, if employed by the owner, as through his reports the engineer can know of dilatory work and can endeavor to remedy the trouble when it begins. See that the unloading does not result in distortion of the steel work, especially of the compression members. A goodly portion of the shop coat of paint is apt to be rubbed or scratched off in shipment and such spots should be touched up, at least in places that will be inaccessible after erection.

As a rule steel erectors do their work thoroughly and conscientiously, but there are times when they will get an idea that there are too many rivets, and that a few left out will do no harm. Therefore it is well to look at the places requiring rivets that are hard to get at and make sure that all are in.

Another important point in erection is the final tightening of bracing in the plane of the upper chords of the roof trusses. If not done carefully, distortion of the truss will result, due to the excessive unbalanced tension on the diagonal ties. That the abutting surfaces of the columns are in contact over the full surface at the splices is also important. Full rivet heads should be insisted upon, even though the contention is often made "that a poor rivet is better than a bolt, and a bolt would do." The practice of battering the ends of bolts to prevent nuts loosening at bolted connections is to be discouraged, as it is uncertain in fulfilling its object. The form of lock washers used in erecting traveling cranes is more certain for this purpose.

Work of Various Building Trades.

It is difficult to obtain good work and speed at the same time, and it is useless to expect better work than is the ruling custom in the locality in which the buildings are being erected. There is a tendency in some sections to think that anything is good enough for a shop building. This results from the demand for a minimum of cost irrespective of quality of work. Often one will find mason contractors who think a ¾ inch mortar joint is all right, and whose ideas of a shoved joint are such as to defeat the desired aim of securing a full joint and a solid wall. The bonding of the inner and outer courses should be good, and anchors for tying the brick work to the structural framing should be placed wherever there is a chance of the brick work breaking away at points where the parts of the work are intended to

be mutually supporting. Many hard-burned bricks absorb water slowly, and if such is the case the joints should not be struck until settlement has taken place.

The time taken to lay brick for any building is little, in relation to the entire time consumed in building, but this period can be profitably occupied in doing foundation and underground work inside of the building. To this end the masons must work from outside scaffoldings on single story shop buildings. Many contractors will object to doing this, claiming difficulty in keeping the walls clean and in lining up the outside courses. Their objections are not weighty enough to balance the advantage to the owner, of having the space within the walls available for doing such work as may save much valuable time in the future. Fig 39 shows the opportunity for pushing work when the masons work from outside scaffolds.

Plumbers are not prone to work accurately to drawings in the location of piping, and their work should be watched as to clearances for cranes, sliding and lift doors and any other subsequent work.

Most foremen of the building trades have risen to their positions primarily for their skill, and they are generally more proud of their craftsmanship than they are of their executive ability. The feeling that their skill is recognized and credited by the engineer will lead the foremen to use extra care to prevent things from slipping through that would reflect on them personally and even to suggest slight changes that would be better than the design calls for. This co-operation of the contracting foremen can often be obtained by using tact, and its value is immeasurable.

Methods of Following and Expediting Progress.

The following method of recording the progress of building operations is based on the premise—that of a piece of work requiring ten weeks to complete 70 per cent of it should be done in seven weeks, or a larger force should be put on to make up the time lost. It may not be out of place to state that the keeping of costs on shop work by the use of "average hour rates" rather than distributing every minute of every man's time, is recommended by one of the leading practical supervisors of cost keeping in the metal-working industry.

The application to construction work is very simple, as the different hour rates are fewer than in shop work. The first thing required is the total number of hours or days necessary

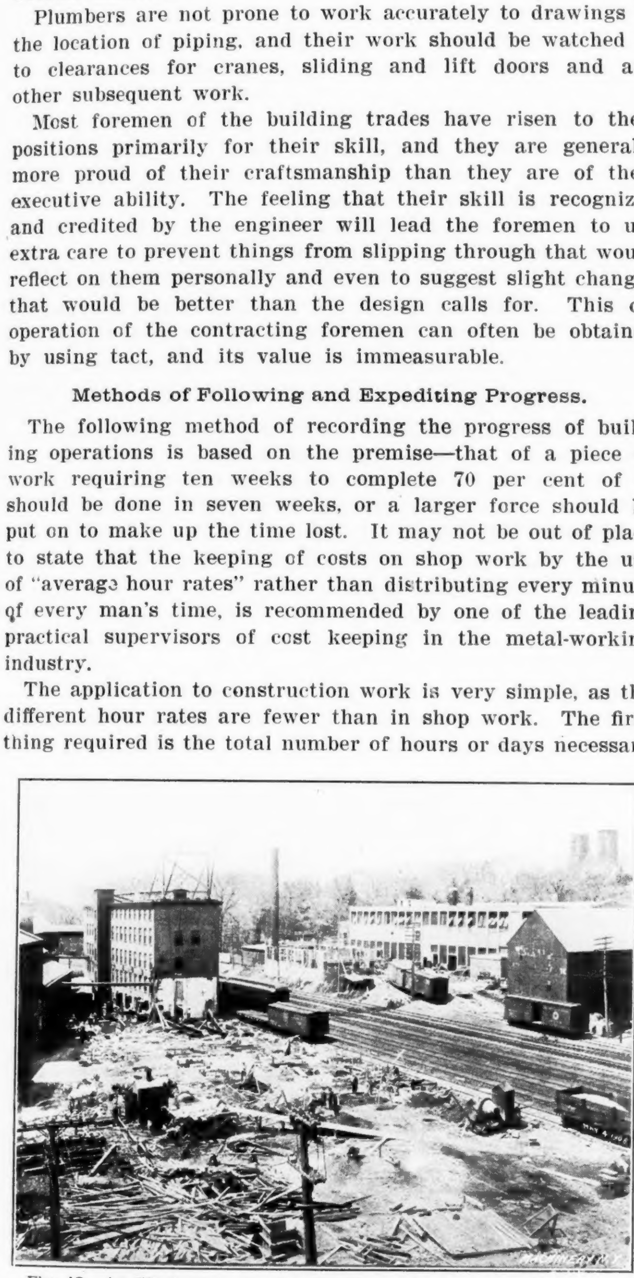


Fig. 43. An Illustration showing the Manifold Duties of the Engineer in Charge of the Large Project of Construction Work.

to complete the work. This total for each branch of the work is obtained from the engineer's estimate of cost, either by summating the number of hours there given in detail or by dividing the cost (pay-roll cost only, refer to fifth article of the series, January issue) by the average hourly rate for that branch of the work, and then by the number of hours to a working day, then by the number of working days in the available time. Thus the average number of men required is obtained. The time actually put in on the work is then easily obtained by counting the number of men at work each morning and afternoon. This can be done without arousing any suspicion that the work is being checked. Of course, allowance should be made for the days lost on account of the season of the year, bad weather and holidays. The available time and the dates from which records should start are shown by the time charts described in the fourth article, December issue, page 253. The progress can be plotted graphically against a predetermined curve on a chart which shows the dates on the horizontal line, and the cumulative number of man-days on the vertical scale. This method involves the least amount of clerical work and shows very plainly whether or not the work is progressing rapidly enough. The vertical scale can also be marked for percentages, and the chart will give the percentage of completion which should be reached on any date, and when filled in, the curve of actual days worked to date will give the percentage which is actually accomplished at that date. As it is necessary to record the number of men working each day, the desired progress can also be shown by the table indicated by the following headings:

Date.	Men at Work.	Cumulative Days.	Required Days.	Required Per Cent.	Actual Per Cent.

This method may not be thought sufficiently accurate for cost keeping for shop work, but it certainly is for construction work, and is far more accurate than the general estimates of percentage of completion, and has the undoubted value of being based on something more than observation and is strong as a support of a claim that the work is behind, if it becomes necessary to make such a claim to the contractor.

The uncertain factor, the figured labor cost as taken from the estimate, should be checked, as it is only necessary to verify the unit of time required for a unit of work. If it is found that this time varies from the estimated time it is easy to modify the curve on the chart. This chance for verification makes it possible to feel more certain that a large project is going right, or to know just how bad things are if they are not going right.

It is hardly necessary to mention the importance of photographs of construction work as a factor in preventing disputes when settling for extras, but the great value of photographs of details, when other work is to be designed or estimated upon, is only realized by engineers who have these record albums in connection with the complete data of estimated and actual costs and other conditions of the problems. Figs. 40, 41 and 42 show stages of a piece of construction work and the details are certainly the equivalent of many pages of a note-book.

Installing and Moving.

It is important that foundations for new apparatus and machines from the old shops shall be ready when the machines arrive on the ground and that facilities are provided for handling and placing the machines without delay in order that the starting up may be systematic and proceed without confusion. Foundation plans for the new machines are easily available, and the time taken to repair old machines before moving should be made use of in obtaining the location of anchor bolts and whatever measurements are required for pits, etc., which cannot be obtained before. The completion of the foundations must also be rushed on receipt of this information.

This is one of the busiest periods in the work of plant extension, as all the many minor items forgotten or deferred must now be met. The machines, as soon as on foundations, must be leveled and made ready for use. The starting up of the machines, the constant operation of cranes and the demands for lights make it absolutely necessary that the power plant be in good running order, and that such changes be made as develop from watching the operation of new apparatus.

On the presumption that the engineer in charge of the construction of a metal-working plant has to do with the

selecting of new equipment both in way of machine tools and equipment for handling and transporting of materials, the testing and running of new machinery should not be left to the shop people. Especially in shops where the heads of departments have worked up from the ranks, there is often a reluctancy to give new machinery a fair chance or to strive for the most that the machinery is capable of. Therefore, the engineer will work to the best interest of his employers and himself if he renders every assistance to any erecting men or demonstrators from the outside, and follows up and records the performance of machines when they are in the hands of skilled operators. The little "kinks" of handling and time-saving used by demonstrators should be noted, as later on the shop men may so handle machines that the performance is not duplicated, and if the engineer has advocated the machine without the earnest acquiescence of the shop foremen, it will be "up to him" to save an efficient machine from being condemned.

Scope of Construction Engineering.

The reason that the author has placed so much stress on the responsibility of the engineer in charge of a large project of construction work is shown in a way by the range of work going on in the scope of Fig. 43. Below the surface of the ground there is tunneling, plumbing and power piping being carried on. The foundry shown at the right is being worked into running order; the foundations are put in for the boilers at the power house of which the mason work is in progress. In the foreground: excavation, concreting, the placing of capstones and the beginning of the steel erection is in evidence. The planning and contracting for the work shown in this one view was done within six months and involved the expenditure of nearly $400,000. If one will but consider the large number of personalities with whom the engineer must deal, and the mass of details for which he must stand sponsor on a job of this size, the difficulty of securing results that are satisfactory to even a *few* people will be understood. The subject is so broad that to treat it in a general way can only serve to bring out a portion of the many things which have to be considered in this class of engineering.

* * *

CRANE HOOKS.*†

H. J. MASTENBROOK.‡

The tables of dimensions and properties of crane hooks found in hand-books usually apply only to hooks of ten tons capacity and under. They are based largely on the results of practice, and are forged from a rod of uniform cross section for reasons of economy in manufacture. In designing a hook of large capacity the matter of weight is of much more importance than cheapness of production; it is therefore important to distribute the metal in the most economical manner, and obtain the necessary strength with a minimum weight. The shape of the cross section of a hook is such that it does not lend itself readily to exact mathematical treatment. However, approximations may be made that are fairly accurate and which experience has shown to be safe.

Let us first consider briefly the development of a general formula. In the formulas:

A = area of section in square inches,
f = allowable fiber stress in pounds per square inch,
P = load in pounds,
p_1 = stress due to pull in pounds per square inch,
p_2 = stress due to bending in pounds per square inch,
I = moment of inertia of cross section,
R^2 = square of the radius of gyration in inches.

See also the accompanying illustration for the notation used. Then

$$p_1 = \frac{P}{A}$$

$$p_2 = \frac{Py_1y_0}{I}.$$

For safety $p_1 + p_2$ must equal f; therefore:

$$f = \frac{P}{A} + \frac{Py_1y_0}{I}$$

which may be reduced to the following form:

$$\frac{P}{f} = \frac{A}{1 + \dfrac{y_1y_0}{R^2}}.$$

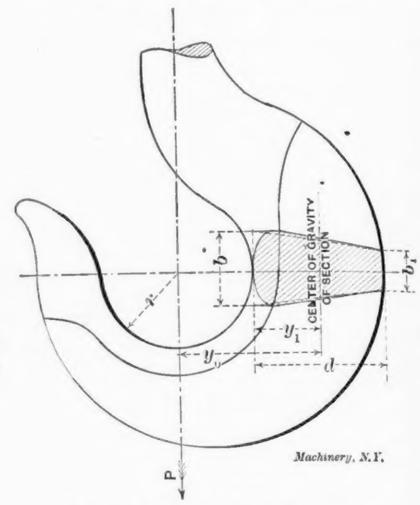
If, instead of the actual section of the hook, we consider the trapezoid as shown by the dotted lines, we then have the following values for the various terms in the formula:

$$A = \frac{b + b_1}{2} \times d,$$

$$y_1 = \frac{b + 2b_1}{b + b_1} \times \frac{d}{3},$$

$$y_0 = \frac{b + 2b_1}{b + b_1} \times \frac{d}{3} + r$$

$$R^2 = \frac{b^2 + 4bb_1 + b_1^2}{18(b^2 + 2bb_1 + b_1^2)} \times d^2.$$



Notation for Crane Hook Formulas.

Substituting in the above formulas $b = 0.65\ d$; and $b_1 = 0.3\ d$, we have:

$A = 0.475\ d^2$,
$y_1 = 0.4386\ d$,
$y_0 = 0.4386\ d + r$,
$R^2 = 0.0795\ d^2$.

Substituting these values in the general formula reduces it to

$$\frac{P}{f} = \frac{d^3}{7.2d + 11.615r} = \text{constant in table in Supplement.}$$

To facilitate the work of design, tables giving values of $\frac{P}{f}$ for various assumed values of d and r may be calculated, and such tables are given in the accompanying Supplement. Hooks designed by these tables have been very thoroughly tested in practice and have given entire satisfaction. For ordinary service, a fiber strain of from 16,000 to 25,000 pounds may be used with safety.

When using the table in the Supplement for designing crane hooks, the load P in pounds which the hook will be required to carry is first determined. Then the allowable fiber stress f is assumed, and the quotient $\frac{P}{f}$ obtained. This quotient is found in the body of the table under the value of the radius r required in the hook. When the nearest value to $\frac{P}{f}$ in the table has been located in the vertical column under the radius, follow the line horizontally to the left-hand column which gives the dimension d directly. All the other dimensions are proportioned from the dimension d, as shown in the engraving, Fig. 2, in the Supplement.

As an example, assume that a crane hook for a 50-ton crane is to be designed, that the radius r is required to be 3 inches, and that the allowable unit fiber stress is 20,000 pounds. Expressed in pounds, P = 100,000 pounds. This divided by 20,000 gives us the quotient 5, which is found in the table in the vertical column under 3 inch radius. It will be seen that the nearest value to 5 is 4.75, and following the horizontal line in which 4.75 is found, to the left-hand column for d, we find d = 7.5 inches. All the other dimensions can now be found by inserting this value of d in the formulas in Fig. 2 in the Supplement.

* * *

The movement for increased facilities for technical education is clearly making progress. Even Palestine is to have an institute of technology at Haifa, Palestine. Mr. Jacob H. Schiff of New York, has contributed $100,000 towards it.

* See also MACHINERY's Data Sheet No. 33, June, 1904: Proportions of Hooks.
† With Data Sheet Supplement.
‡ Address: 212 Franklin Ave., Bay City, Mich

AUTOGENOUS WELDING AS A MEANS OF REPAIRING CYLINDERS.*

HENRY CAVE.†

Breakages in automobile cylinders can be divided into three main classes which cover at least ninety per cent of the cases. The majority of these breakages can be satisfactorily repaired by means of the oxy-acetylene flame as carried out by the Autogenous Welding Equipment Co., Springfield, Mass., with their Davis-Bournonville apparatus, the cylinder being as good as new, and better in some cases. Autogenous welding, as the process is called, consists of fusing the metal around the break by means of an acetylene flame, the heat of which is concentrated to a very small area by being burned with pure oxygen in a torch giving a flame temperature of over six thousand degrees F. Additional metal is added where necessary from a rod of the same material, and the process is practically recasting the part locally.

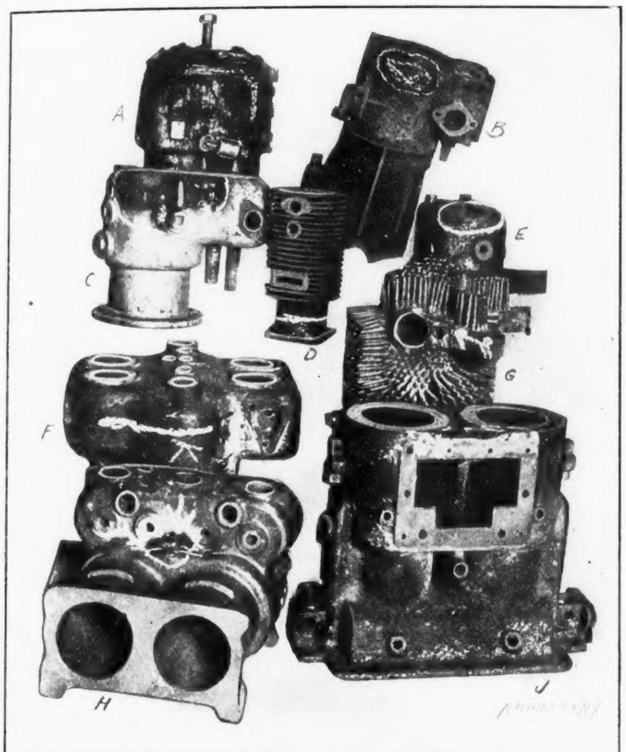


Fig. 1. Group of Broken Automobile Cylinders that were repaired by Autogenous Welding.

Autogenous welding is proving a great boon to those who are unfortunate enough to have their automobile cylinders broken, as they can be satisfactorily welded and in the majority of cases, with a little trimming off, the repairs will not show. This is a particularly valuable feature as some owners wish to sell their cars without the repairs being noticed. Cylinders with cracks are sometimes brazed, but owing to the necessity of heating the whole cylinder to a good red heat to even up the contraction strains, so as not to crack when cooling, the bore of the cylinder is generally warped, and the job requires a lot of finishing as the spelter and flux spread considerably and are hard to remove. Also, owing to the dirt and rust in the crack it is difficult to get the brazing below the surface; the high temperature necessary will sometimes crack the cylinder elsewhere.

Water Jackets Broken by Freezing.

The largest class of cylinder breakages—mainly due to carelessness or misfortune, probably in most cases the former—is caused by allowing the water jacket to freeze, resulting in the breaking of the water jacket wall. This cannot always be termed carelessness, as I have known an automobile to have all its water jackets cracked as early as the middle of October when the owner had no thought of such a thing being possible. I have also known of cars being "hung up" on the road in cold weather, the driver opening the drain cocks before he left to summon help and upon his return finding the water frozen with the usual result. This accident probably is due to too small drain cocks. Also, it has frequently happened that when shipping a car by rail in winter the drain cocks were opened, but due to some pocket in the water system (in some cases very small ones) which did not drain, the cylinders have become fit subjects for the autogenous welder.

Curiously enough the majority of cylinders cast from the same patterns will break in just the same place when frozen. In a number of cases the break causes a piece of the wall of the water jacket to be entirely detached, and the breaks occur so nearly alike, in similar cylinders, that it would be possible to take the detached piece from one and weld it into another, even the smaller irregularities coinciding.

When a break of this nature is autogenously welded, by means of the oxy-acetylene flame, the crack or edge of the broken part is prepared so as to leave a groove nearly through the metal. The whole part is then uniformly heated to about five hundred degrees F. This temperature is not high enough to warp the bore, as has been repeatedly proven by careful measurements before and after treatment. The sides of the groove are fused together and filled from a rod of cast iron. The resulting weld is very neat in appearance; it generally requires no finishing and is as strong as the original wall. As a very small number of heat units are absorbed by the part, owing to the intense heat of the flame fusing the metal before the heat has time to spread, there is seldom any trouble with cracks when the metal contracts in cooling.

Cylinders *A*, *F*, *H* and *J*, Fig. 1, were welded in this manner. The weld on *F* was along the chalk line, and was ground off so that all signs of it were effaced. A piece of the water jacket had been knocked out of cylinder *H* when the casting was being smoothed up ready for painting at the factory; the successful welding, however, saved the cylinder. A crack along the top corner of *J* is shown welded.

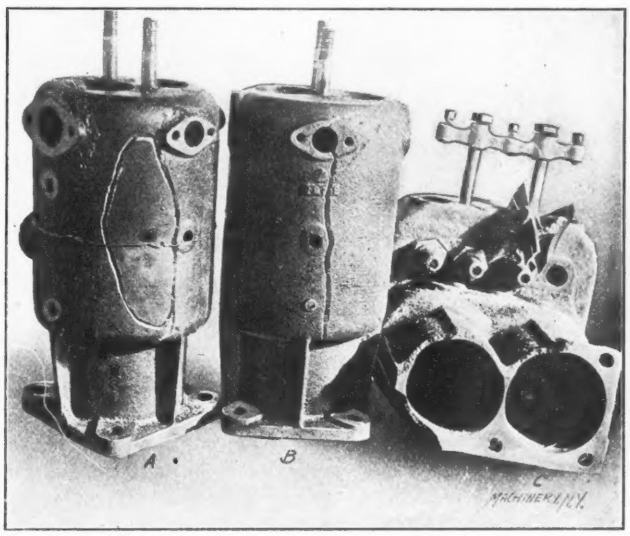


Fig. 2. Two Cylinders with Cracked Water Jackets prepared for Welding. Twin Cylinders with Broken Flanges to be Welded.

A and *B*, Fig. 2, show common types of breakages which are being satisfactorily welded every day. The crack in *A* is seventeen inches in length. Both cylinders are grooved out ready for welding.

Cylinder Wall Broken.

The next class of breakages, in order of frequency of occurrence, is that in which the wall of the cylinder, combustion or valve chamber, is broken or cracked. These breaks are, in most cases, due to freezing, but a certain number of them are due to the designer making a large flat surface without adequate ribbing to support the pressure of the explosion.

Another cause is the breakage of the connecting-rod, allowing the piston to strike the top of the cylinder. Serious damage from this cause occurs most frequently in two-cycle engines as the deflector on the piston readily punches a hole in the combustion chamber wall. Fig. 3 shows a cylinder

* For previous articles on oxy-acetylene flame autogenous welding see "The Application of Autogenous Welding to Automobile Repairs" by Henry Cave, December, 1908, and other articles there referred to.

† President of the Autogenous Welding Equipment Co., 92 Hayden Ave., Springfield, Mass.

having this defect, and Fig. 4 shows the outside after welding. This kind of break also often occurs due to foreign substances such as the head of a broken valve getting between the piston and the cylinder head.

This class of breakages is the most difficult to repair, as it is necessary in most cases to cut out a section of the water jacket to be able to work on the inner wall, the only deviation occurring when the break happens to be opposite a large hand hole. This operation has a singular resemblance to the well-known trepanning operation performed upon the human skull.

It can be readily seen that it is practically impossible to make a repair when the break occurs between two cylinders or behind the valve chamber, as these parts cannot be reached with the small flame.

If the crack occurs in the bore it is necessary to carefully weld to within a sixteenth inch of the bore, or the finished surface will be spoiled; the crack left in this way is of small importance, as sufficient metal can be built on the outside so that there is no doubt about the strength. After welding the break the section of the water jacket which was removed is welded back in place.

As it often is impossible to determine the length or exact locality of the cracks before cutting away the jacket and is

Fig. 3. Cylinder with Section of Water Jacket removed to repair Crack in Inner Wall.

Fig. 4. Cylinder shown in Fig. 3, after Welding.

desirable to remove as small a section as possible, it often is found necessary to cut additional pieces out, thus necessitating welding a number of small pieces back in place when finishing the job. To restore these pieces sometimes is impracticable, and a sheet steel substitute must be hammered out and welded in place. With care this piece can be shaped so as to coincide with the piece removed, and cannot be detected when welded in place. A case of this kind is shown in *B*, Fig. 1. The part shown cut away was neatly replaced by sheet steel, as shown at *A*, Fig. 5.

The water in freezing will often crack both the water jacket and cylinder wall. The former being readily seen is generally thought to be the full extent of the damage, particularly as it is practically impossible to make a test until the crack is repaired. The work may then have to be cut out to find further defects. This was the case in the cylinder shown at *A*, Fig. 1, the right angle crack being first welded; the break extending from below the hole shown cut out across the other side was welded and the cover replaced. A similar break then being discovered in the other cylinder, the relief cock boss for both cylinders was entirely detached and welded back in place.

The cover plate on the cylinder shown in Fig. 5 was also broken in freezing, at the same time as the cylinder wall was broken, and is shown welded.

Fig. 6 shows a cylinder having a crack eight inches long, located at the corner of the combustion head, that was welded. The part cut out of the water jacket is also shown. It will be noticed that this operation required cutting through a supporting lug. The water jacket part successfully welded back in place is shown at *C*, Fig. 1.

The cylinder shown at *E*, Fig. 1, had a hole to be welded to accomplish which it was thought necessary to remove the section shown chalked. A much larger section, however, had

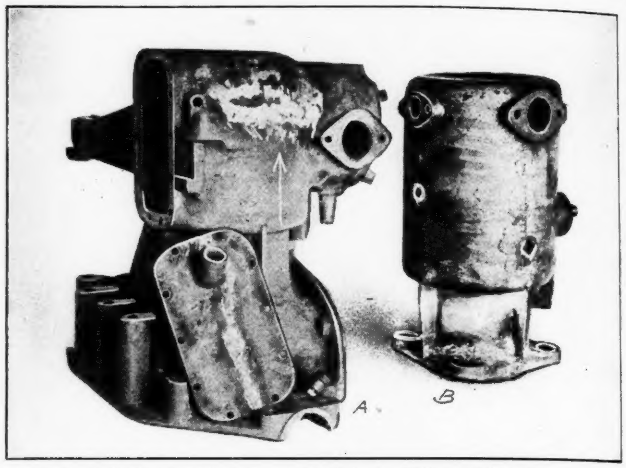


Fig. 5. Cylinder A, (Fig. 1, B) repaired by inserting a Steel Piece, bent to Shape, and autogenously welded in Place.

to be cut out so as to take care of a crack running down the side; the two pieces removed were welded together before they were replaced.

Broken Flanges.

The next order of breakages in point of number are those in which all, or a portion of the flange, which holds the cylinder to the crank case is broken away, due either to insufficient metal to withstand the strain or to carelessness in assembling.

These breakages occur in two ways; the wall of the cylinder may be broken away or part of the flange may be cracked off. In the latter case it is an easy matter to make the repair, but when the break runs through into the bore of the cylinder considerable care is required. First it is necessary to consider whether it is desirable to weld in the bore which would then require machining or at any rate filing out, or only groove and weld from the outside to within a sixteenth inch of the bore, sufficient metal being added to the outside to insure strength. The latter method, of course, leaves the crack on the inside, which can, however, be smoothed down and is not objectionable for a repair job;

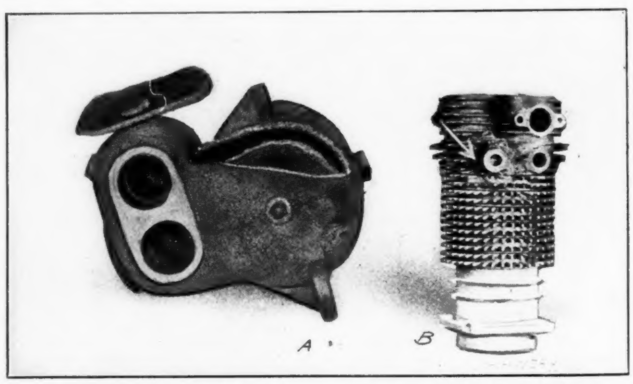


Fig. 6. Cylinder Cracked in Inner Wall, showing Large Section of Outer Wall removed to weld the Crack.

Fig. 7. Air-cooled Cylinder on which Boss for Ignition Plug was autogenously welded.

not interfering with the satisfactory operation of the motor in any way.

In addition to these three classes, there is a large variety of other breakages, no two of which are alike, that can be repaired successfully by the oxy-acetylene torch, such as broken inlet and exhaust flanges, holes knocked through the barrel of the cylinder by broken connecting-rods, welding of broken supporting brackets, as shown at *G*, Fig. 1, the bracket or lug shown having been entirely detached.

In addition to this, considerable welding can be carried out for the manufacturer, such as the welding on of additional bosses for dual ignition systems, as shown in Fig. 7, building up bosses that did not "fill" in castings, welding porous spots which show up after machining or adding metal anywhere it may be required.

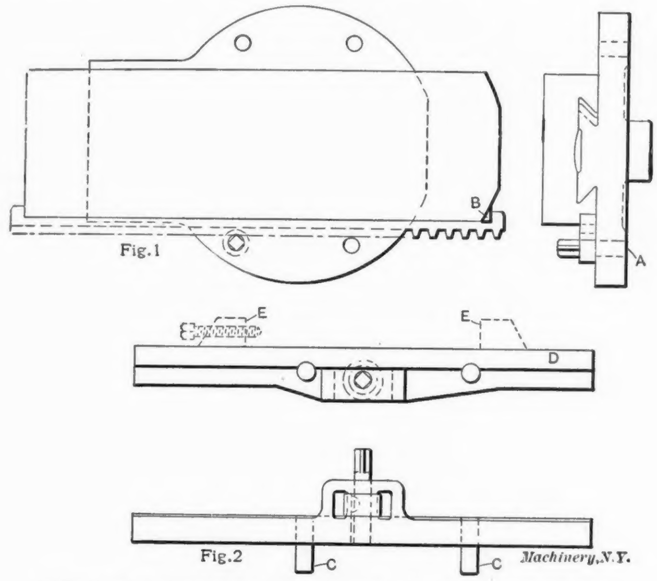
LABOR-SAVING DEVICES FOR SCRAPING OPERATIONS.*

ALFRED SPANGENBERG.†

Alfred Spangenberg.‡

There are a number of elements entering into the cost of scraping operations, other than that of scraping proper, which are always of sufficient importance to merit the closest consideration. In fact, very often it is the lack of attention to these other factors that accounts for much lost time. This is particularly the case in such laborious operations as "straightening out." This operation consists in moving the sliding machine member with the packing set up tightly, over the fixed member, in order to find the bearing on the packing, and finally to feel the "high spots." It is obvious that the packing must be adjusted to make the sliding member pull hard, otherwise it would be impossible to detect any variation in pressure due to inequalities in the machining.

Even on comparatively light work this pulling and pushing, if done directly by hand, involves more labor than is required in the actual operation of scraping. In work of this character, where brawn and muscle are prime requisites, we are dealing with the human elements which may cause a slowing



Figs. 1 and 2. Device for Pulling Planer Slide back and forth, and Support for Rack and Pinion.

up of production. The principal point to be observed is that a workman has a certain amount of physical endurance, and if the greater part of his energy is concentrated on the productive operation of scraping, a material increase in production will result; because of this fact, it becomes of extreme importance that means be provided for making the task of pulling easier.

The classifications of work determining the selection of a proper type of pulling device are: (*a*) Planer slides, lathe rest slides and work of a similar character; these are usually pulled directly by hand. For this work a rack and pinion operated by a ratchet wrench is the most convenient type of pulling device; the tight and loose places in the work being easily detected. (*b*) Boring mill rams, shaper rams, milling machine tables and similar work, which is comparatively short and too heavy to be pulled by a ratchet wrench. The type of device suitable for this class of work is a rack and pinion operated by power. The pinion being driven through a frictional device, the slipping of the driven friction member indicates the "high spots" in the work. (*c*) Planer cross-rails, lathe beds and work having large dimensions, and where the pull required is long. For this class of work the pulling

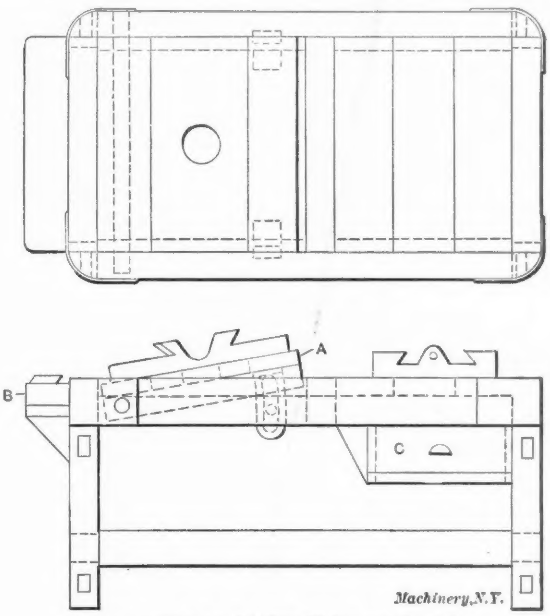


Fig. 3. Bench for Holding Slides and Swivels.

device takes the form of a power-driven wire rope drum. A tension indicator interposed between the work and the wire rope indicates any variation in pulling force required to move the work.

Concrete examples of the conditions stated in class (*a*) are illustrated in Figs 1, 4. and 5. Fig. 1 shows the application to a planer slide and swivel, of a rack and pinion operated by a ratchet wrench. In this case, the clamping bolt hole *A* in the swivel is made use of as a bearing for the pinion. A lug is cast on the slide at *B* to provide a square seat for the projection on the rack. The rack is a loose fit endwise on the slide and is easily removed.

When the design of the swivel is such that the clamping bolt hole *A* is too near the slide to be used as a bearing for

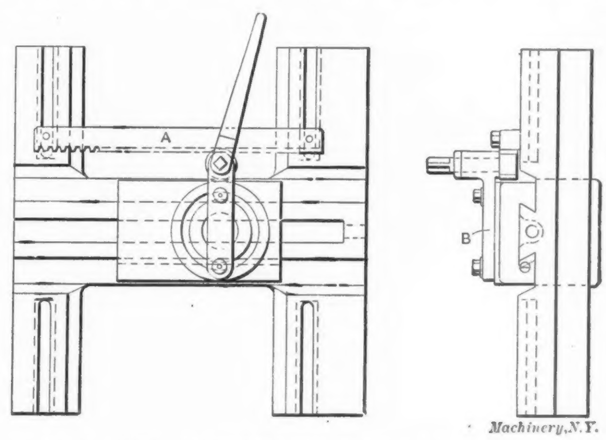


Fig. 4. Method of Attaching Rack and Pinion to a Lathe Rest.

the pinion, the device shown in Fig. 2 is substituted. The pins *C* fit into the holes in the swivel and hold the device from moving. The surface *D* supports the rack and keeps it in place when the slide is in the extreme positions. The lugs *E*, indicated by the dotted lines, show how the device can be attached to a swivel in which the clamping bolt holes *A* (Fig. 1) are not available for supporting the device.

The special bench represented in Fig. 3, while not strictly a pulling device, is shown because it is very useful for holding

* See also MACHINERY, February, 1909: Application of Lifting Devices to Assembling Work.

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‡ Alfred Spangenberg was born in Brooklyn, N. Y., in 1876, and received a high school education, after which he completed a correspondence course in mechanical engineering. He served a four years' apprenticeship with the Pond Machine Tool Co., three years of which were in the machine shop and one year in the drawing office. He has been employed by the Hercules Seamless Drawn Tube Co., Garwood, N. J.; National Meter Co., Brooklyn, N. Y.; and the Pond works of the Niles-Bement-Pond Co., Plainfield, N. J., where he is now employed as foreman of the turret lathe erecting department. Mr. Spangenberg has made a specialty of assembling work, and his article on the subject published in the February issue of MACHINERY illustrated a number of practical shop devices for scraping and fitting, which are of his own design.

slides and swivels and work of a similar character, during the operations of pulling and scraping. The top half of the bench shown tilted is for holding the swivel on an angle, the object being to easily keep the slide against the fitting angle of the swivel while finding the bearing before the packing is

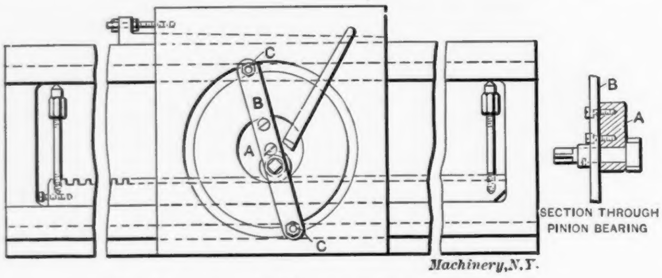
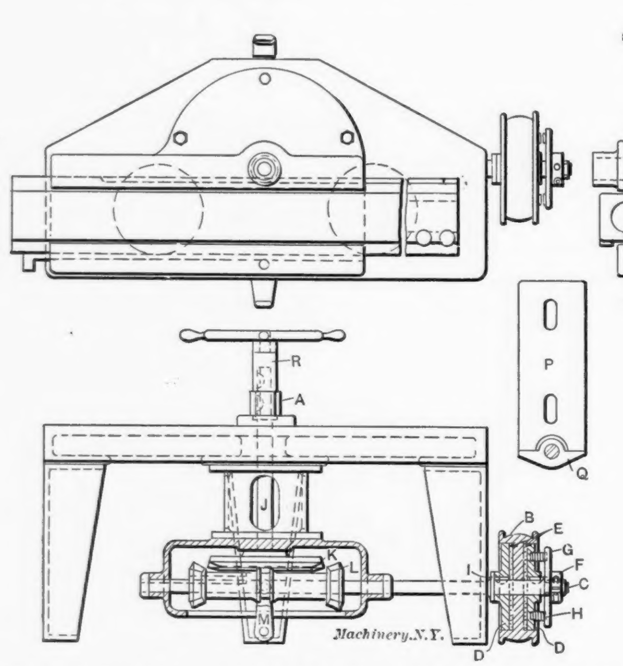


Fig. 5. Rack and Pinion for Pulling a Planer Slide.



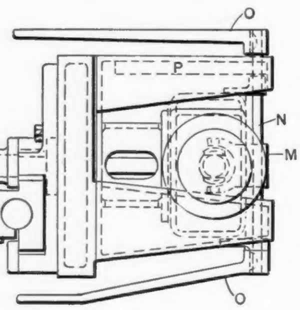


Fig. 6. Machine for Imparting Motion to Boring Mill Rams while Scraping.

fitted. When the packing is being fitted, and during the operation of "straightening out," this swinging top A is kept level. The magnetic chuck B provides a very convenient means for holding the packing while it is being scraped. A drawer C is for keeping the scrapers, oil stone, etc. The bench is made of wood and iron and bound at the corners.

Fig. 4 clearly indicates the method of attaching a rack and pinion to a lathe rest and shoe. The rack A is bolted to the rest by means of the T-slots. The pinion bearing casting B extends across the top of the shoe and is clamped by two bolts in the circular T-slot. The rack is quickly made parallel with the ways of the rest by placing the shoe, with the pinion clamped to it, in one extreme position and clamping the adjacent end of the rack in proper mesh with the pinion; then repeating the operation with the shoe in the other extreme position.

The method of attaching a rack and pinion to a small planer cross-rail and saddle is shown in Fig. 5; it is practicable to apply this method for pulling the saddles of cross-rails up to sizes of 48 inches. Referring to the illustration, the rack rests on the rough inside surface of the cross-rail, and is held in position by the screw, studs and nuts as indicated. The adjustment of the pinion into proper mesh with the rack is accomplished by making the pinion bearing A in the form of an eccentric bushing fitting into the hole in the saddle. The eccentric bushing is clamped by the strap B and bolts C.

The principles embodied in the design of the pulling machine illustrated in Fig. 6 are adaptable to the work mentioned in class (b). This machine is made for pulling boring mill rams; the simplicity of the design is immediately apparent from a study of the three views shown in the sketch. The top and end views show a right-hand ram and swivel in position on the table of the machine. This table is supported on three legs to avoid any tendency to "wind," and the design is adapted to hold either right- or left-hand swivels.

The machine illustrated is belt-driven, although a motor drive could be easily substituted. The mechanism for driving the pinion A, which meshes with the teeth of the ram, is clearly shown in the side view. Referring to the sectional view of the friction pulley, the driving member is the flanged pulley casting B, having a solid web. This member is a running fit on the shaft C and friction disks D. The friction disks are the driven members, and are keyed to the shaft C. Between these disks and the pulley casting are two leather washers E. The amount of friction required is adjusted by means of the split nut F, which moves the spring disk member G (keyed to the shaft) and compresses the twelve springs H. This regulates the pressure on the friction disks, leather washers, and pulley; the thrust is taken by the nut F and collar I on the shaft.

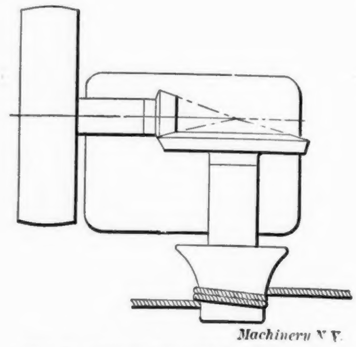


Fig. 7. Winch Superseded by Pulling Machines in Figs. 6 and 8.

The leather washers are prepared by being soaked in oil for 24 hours. This preparation, together with the action of the springs, provides a very uniform and positive slippage of the driven members when the load is excessive.

A motion in either direction is imparted to the pinion shaft J by the bevel gear K and the double bevel pinion L. The bevel pinion is operated by the yoke M, shaft N and oper-

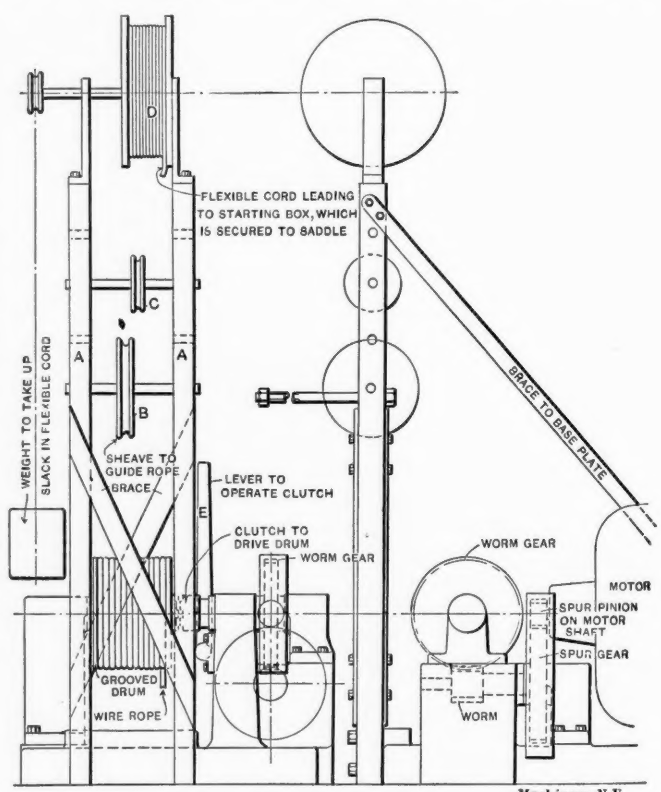


Fig. 8. Pulling Device for Cross-rail Saddles.

ating levers O. The detail sketch of the weight P shows its action on the double rocker arm Q, which is pinned to the lever shaft N. It is obvious that this device keeps the double bevel pinion in a central position when the hand levers are not being operated. The hand-wheel sleeve R is a sliding fit on the pinion shaft and its key.

In operation, the swivel is centered by its hole fitting the hub cast on the table, and clamped by the bolts as indicated. When the packing and gibs are being fitted, the hand-wheel is left off the machine, and the ram only moved back and forth for a short distance near the center of its travel. After the operation of "straightening out" the ram is completed, the hand-wheel is used to pull the ram by hand (once or twice) to make sure the ram pulls evenly from end to end of its travel. The friction is adjusted so it will just pull the ram when the packing and gibs are set to a rather tight running fit. The "high spots" in the ram are indicated by the friction slipping. The machine is geared to move the ram at about the rate of 15 feet per minute. A modification of this machine is adaptable for pulling any work of comparatively short dimensions, by coupling the sliding work member to a rack supported in suitable guides and driven by a mechanism similar to that shown in Fig. 6.

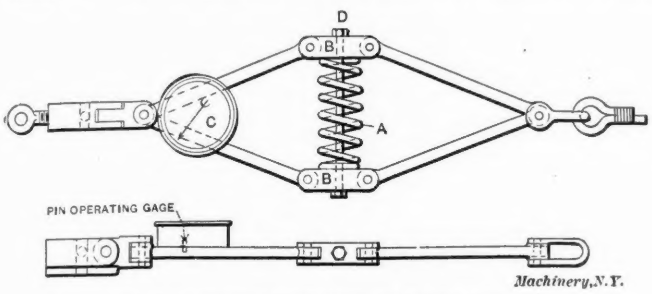


Fig. 9. Indicating Mechanism for Pulling Device.

The type of pulling machine illustrated in Fig. 8 is particularly well adapted to the work mentioned in class (*c*). The general features of the machine comprise a heavy cast-iron base carrying the motor, wire rope drum and driving mechanism. Bolted to the base are two upright steel bars *A*, which are made rigid by the braces as indicated. These bars support the wire rope idler sheaves *B* and *C* and the electric conductor cord drum *D*. The holes in the bars *A* are for carrying the wire rope sheaves at a height to suit the work, it being desirable to have the rope attached to the gage, measuring the pull, as nearly level as possible.

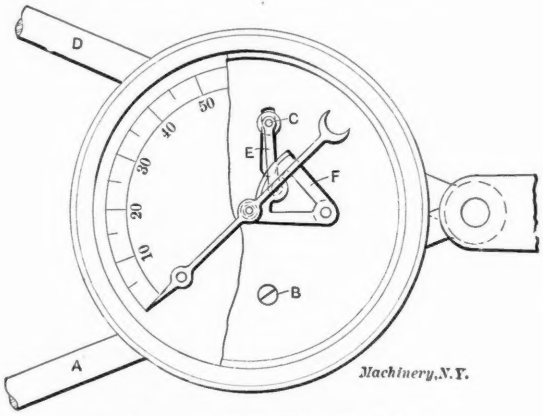


Fig. 10. Detail of Gage shown in Fig. 9.

It will be seen that the machine is self-contained as far as the application of power is concerned. The spur pinion on the motor shaft meshes with the gear on the worm shaft. Between the bearings for this shaft is the worm; this worm drives a worm gear on a cross-shaft. On the cross-shaft are also a sliding clutch and wire rope drum. This drum has clutch teeth cast on one end and is driven by the sliding clutch. The lever *E* is for operating the sliding clutch. The advantage of this clutch is to facilitate the setting of a tension indicator and wire rope onto the work.

The tension indicator illustrated in Fig. 9 and used in connection with the pulling machine just described is essentially a double toggle joint. A force pulling on the wire rope, with the indicator attached to the work, compresses the spring *A* between the two short links *B*. The amount of compression is indicated by the index hand on the dial of the gage *C*. The function of the stud *D* is to limit the outward travel of the lever arms and thus reduce their movement by keeping the spring under a slight compression when there is no load, *i. e.*, there is no movement of the lever arms until the pull is sufficient to move the work. This avoids the tendency of the gage to jump or vibrate.

The construction of the gage is clearly indicated in Fig. 10. The body of the gage is pivoted to the lever arm *A* by the screw *B*. A stud *C* screwed into the lever arm *D* passes through a slot in the body of the gage. A shoulder on this stud and the screw *B* keep the gage in place. The link *E* connects the stud *C* with the sector *F*. The teeth on this sector mesh with the pinion on the index hand shaft. There is no stop pin at 0 for the index hand, the return to 0 being controlled by the stud *D*, Fig. 9.

Referring now to Fig. 9, it is evident that since the relative movement of any two levers of the toggle joint is not in direct proportion to the amount of tension applied to the device, compensation should be made in the dial graduations. This refinement is not necessary, however, as the requirements simply are that the gage indicate *variations* in tension and not the *amount* of variation measured in any definite quantity.

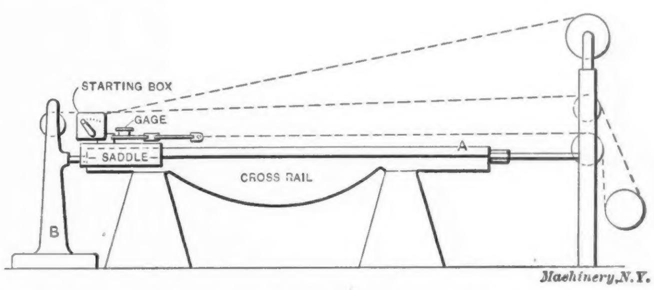


Fig. 11. Pulling Machine, Fig. 8, and Tension Indicator, Fig. 9, in Position for Moving a Cross-rail Saddle along its Ways.

Fig. 11 shows the pulling machine and tension indicator in position for pulling a planer cross-rail saddle. The cross-rail is shown lying face up on suitable iron parallels. This is the position for fitting the packings and "straightening out" the angle. When the surface *A* is being scraped, the cross-rail is turned right-side up. In this case the idler sheave shafts are moved up in their supports so as to keep the wire ropes level. The pulling machine is not fastened to the floor; its weight and the braces keep it in position. The same conditions exist in the case of the idler pulley stand *B*.

The wire rope for pulling the saddle back to the starting point is fastened to the eyebolt shown in Fig. 9. The swivel block of the indicator is bolted to the T-slot in the saddle. When the saddle is pulled backwards the packing is left loose.

The starting box and reversing switch for the motor are on a board which is fastened to the saddle. The weight and cord attached to the sheave on the drum shaft, Fig. 8, take up the slack in the electric cable as the saddle moves forward. The rate of traverse is about 10 feet per minute.

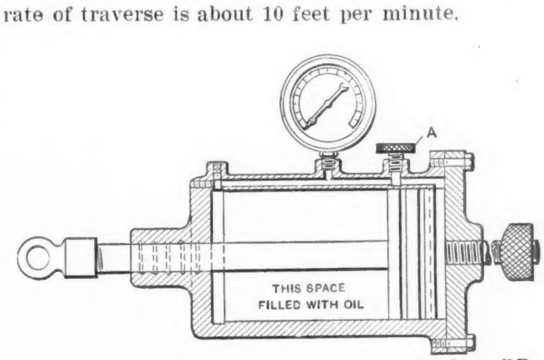


Fig. 12. Tension Indicator which proved a Failure.

In operation, the saddle is moved for a short distance near the center of the cross-rail to fit the packings. During the operation of "straightening out" the cross-rail, the saddle is brought to the position shown in the sketch, the packing is adjusted and the operator starts the motor. By watching the gage, the operator marks on the cross-rail with a piece of chalk the tight places. When the surfaces being tested are parallel with those that have previously been surfaced with a straight-edge, the index hand on the gage will remain fixed from end to end of the cross-rail. The packings are, of course, tightened one at a time.

It will be observed that the gage shown in detail in Fig. 10 consists of parts from a standard pressure gage. The reason for using this was a special cne in this case.

When the pulling machine shown in Fig. 7 was designed by the writer a hydraulic tension indicator, illustrated in Fig. 12, was made. The general principles of this indicator are immediately apparent from a study of the line engraving.

Although the piston was grooved, and the cylinder and piston ground to insure their being a good fit, trouble was experienced from the oil leaking past the piston. Provision was made for returning the oil to the front of the piston by opening the valve *A* and pushing the piston-rod back. The principal cause of its failure, however, was the fact that the gage was too sluggish in its action. The sliding members to which the indicator was attached, had to travel quite some distance before the gage indicated the actual tension.

The indicator above referred to was then designed by the writer, using parts from the pressure gage. This type proved to be very simple and efficient.

The engraving, Fig. 7, represents a power-driven winch that was superseded by the pulling machine described in this article. The advantages possessed by the latter type are at once apparent; they are time and labor savers. The principal point to be gained by their employment, however, is the fact that far more accurate results are obtained.

* * *

BROACHING AUTOMOBILE PARTS.

ETHAN VIALL.*

There is a decided prejudice in some shops against the broaching of keyways, but where the broaches are properly made, the quickness, ease, and accuracy with which keyways may be cut in almost any metal, is astonishing to those accustomed only to the work of the ordinary keyseating machine. The principal difficulties encountered by those who have only experimented a little with broaches, have arisen from the fact that, as a rule, too few teeth have been cut in them, thus compelling six or seven teeth to do the work at one pass, that would require twenty-five or thirty strokes of the cutter on the keyseating machine. Where too few cutting teeth are used there is not only the strain of the heavy bite, but the cut metal fills up between the teeth and either scores the slot or breaks the broach. In addition to an ample number of well-spaced cutting teeth, a number of full-sized teeth should be left on the broach to insure accuracy, and long life to the tool, for where only one or two sizing teeth are used, they soon wear away under the excessive task and the resulting keyway is undersize and causes trouble. Not only must good judgment be used in the making of keyway broaches, but in all of the other forms as well. Of course there are some classes of broaching work where it is only possible to use a few teeth in the broach, but as a general rule plenty of cutting and sizing teeth, as well as ample chip space, should be put in if the nature of the work and the stroke of the machine will permit.

The hardening of the broaches also calls for the exercise of a great deal of judgment and "horse sense," for with these as with other cutting tools, a careless or ignorant hardener can spoil the work of the most competent designer or painstaking toolmaker.

In many cases the character of the work necessitates the broach being pushed through the metal, but for regular keyways, and wherever possible on other work, the broaching should be done with a drawing cut, the broach being supported by a guide or bushing. Draw-cut broaches that are used to cut double keyways, should have a guiding rib extending their entire length, which accurately fits the slot in the guide bushing. This form of flat broach, stiffened and guided by a rib and running through a slotted bushing, is preferable in many ways to the round-bodied self-supporting form, where close accurate work is desired.

In the construction of automobiles, where the Woodruff system of keying is almost universal, the broaching process is particularly adapted to the work, and at the factory of the E. R. Thomas Motor Co., Buffalo, N. Y., not only are all keyways broached that are usually cut on the keyseater, but this method is used for a number of other classes of work that are generally done in a more round-about way. Much of the broaching work is in direct charge of C. B. Buxton, the assistant superintendent, and his practical experience and ideas, together with those of the tool-designer, Lucien Haas, have done much to simplify the difficulties encountered from time to time, thus placing their broaching practice ahead of a majority of the other shops in this respect.

A good idea of the class and variety of the broaching work done at the Thomas plant may be obtained from Fig. 1, while a few of the broaches are shown in Fig. 2. The broaches *A* and *D* are for cutting double keyways, and the guiding rib is very plainly shown; *C* is a broach for cutting a single keyway, and works in a slotted bushing; *B* is a self-guiding broach for cutting the spring notches in the segments of what is known as the Westinghouse piston ring. All of the larger broaches are of the draw-cut type, while the small ones are pushed through the metal. It will be noted by carefully examining the broaches shown, that the notches between the teeth are not sharp at the bottom, thus lessening the tendency to crack at these places.

The draw-cut work is done on the type of machine shown in the illustration, Fig. 3, where the method of holding the work is well illustrated. The piece being broached has a taper hole, and it is set in the jig at an angle in order to make the keyway parallel with the side of the hole. As the small end of a draw-cut broach must be thrust through the hole in the work and then fastened to the draw-head of the machine, some quick method of locking the broach to the draw-head must be used. For the broach shown at *B*, Fig. 2, a socket and pin are used on the draw-head, but for the broaches shown at *A*, *C* and *D*, a lock shown at *E*, Fig. 4, is used. This lock consists of two parts as shown, which are placed together with the broach and the grooved end of the draw-head between them. The collar *F*, which hangs loosely on the spindle, is then slipped over the parts *E*, thus locking them securely in place, yet allowing a certain amount of floating action. At *G* is shown another style of draw-head lock. The broach end is round and notched on each side, while the shape of the slot in the lock-slide is seen at a glance. The slide is lowered until the end of the broach can be slipped through the round hole *J* at the bottom of the slot, and the broach is then pushed in until the slide drops down into the notches locking the broach to the draw-head. At *H* is shown a guide-bushing for a double keyway broach, while at *I* is a jig for holding small cams while broaching out the keyway, the end of the guide-bushing being shown in the hole.

A turret arrangement for use in broaching to a shoulder is shown in Fig. 5. This device is extremely useful and efficient for doing this class of work. The broaching tools in the turret are not indexed in any way, but are swung around by hand and the pilot inserted in the hole in the fitting which is firmly held in a jig as shown.

* * *

HINT FOR LEARNERS OF LETTERING.

An approved method of learning to letter drawings neatly is somewhat like that of learning to walk—a child creeps before it stands, and the learner of lettering soon finds out that he can imitate the approved free-hand style commonly used for legends on drawings much easier if he makes a broad flat letter in the beginning, thus:

When learning to letter make the letters broad and flat, thus:

This style of lettering represents the creeping period, but after much practice the learner is able to give his letters more height and less base until finally his lettering looks something liks this:

As proficiency is acquired make the letters narrower, space closer and give more height.

Young draftsmen who are troubled by inability to letter neatly and rapidly may find a valuable hint in the above.

* Associate Editor of MACHINERY.

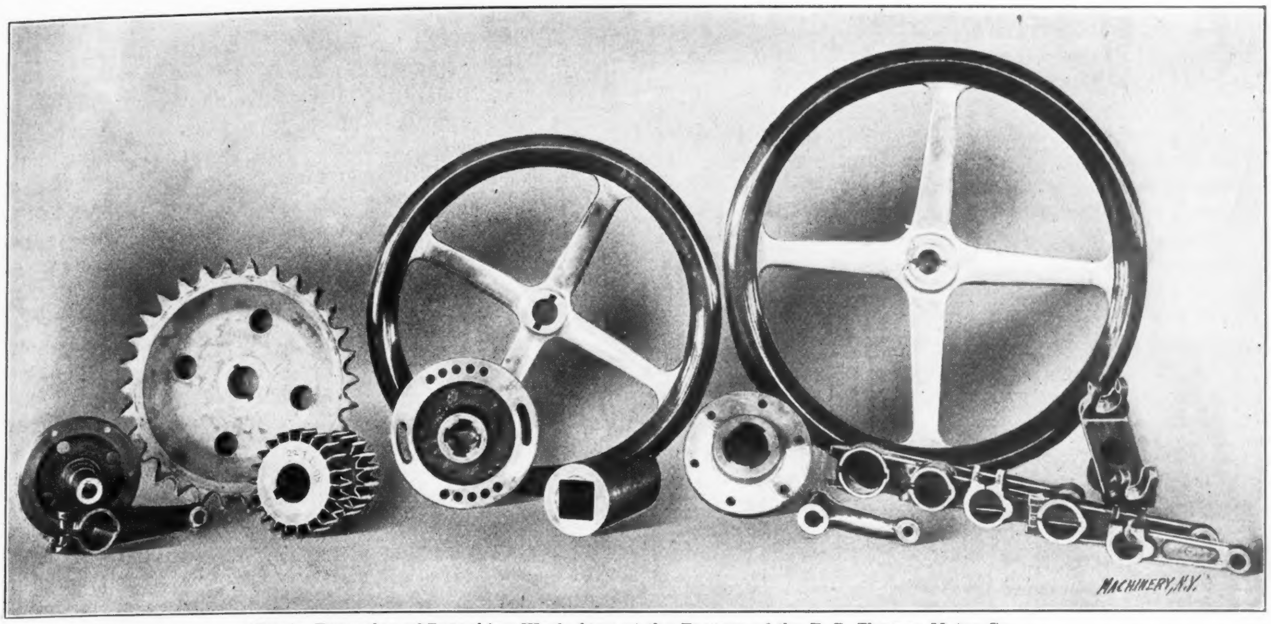


Fig. 1. Examples of Broaching Work done at the Factory of the E. R. Thomas Motor Co.

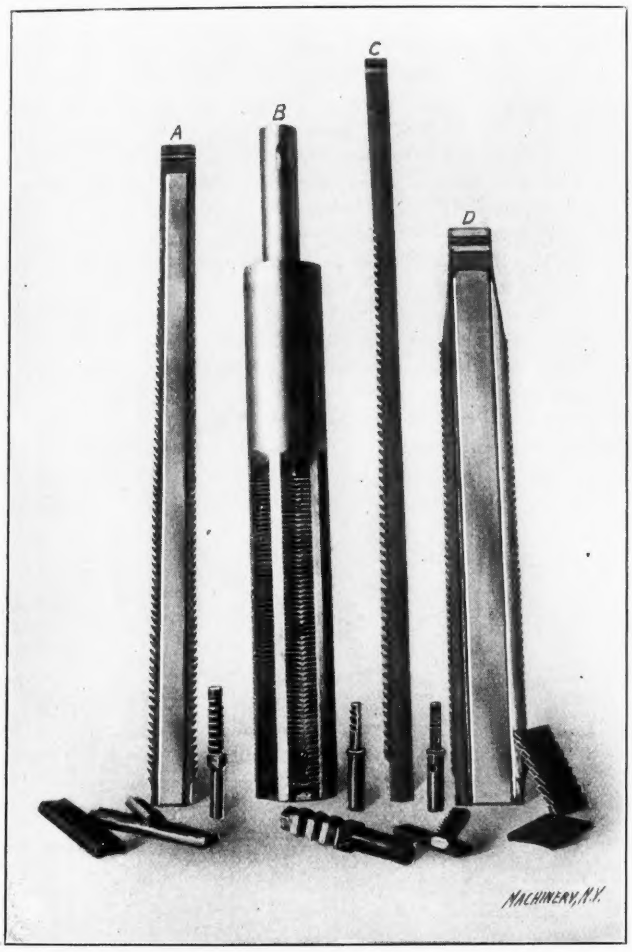


Fig. 2. Some of the Broaches used for Broaching Motor Parts.

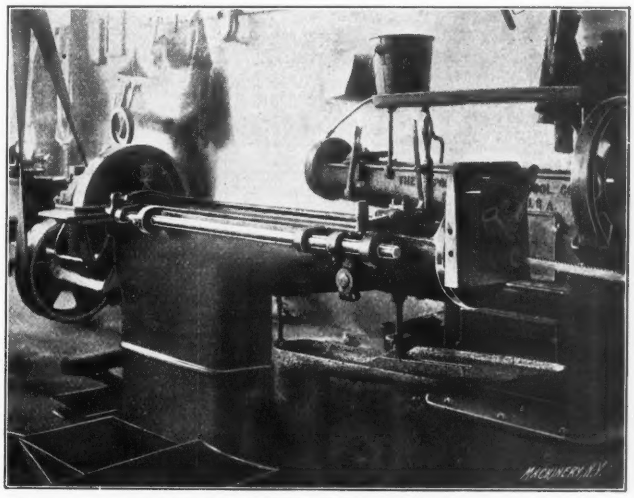


Fig. 3. Draw-cut Broaching Machine, showing Single Keyway Broach and a Jig for Holding Front Axle Part.

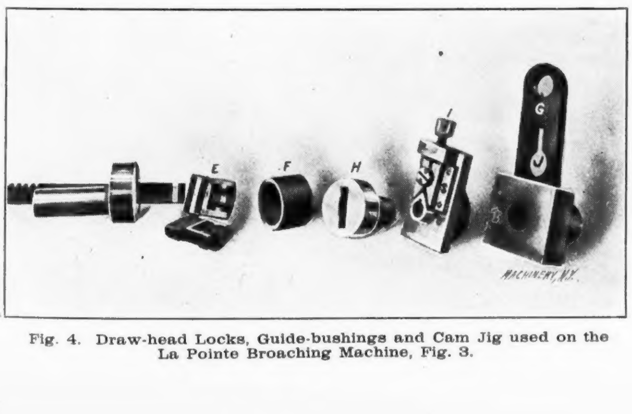


Fig. 4. Draw-head Locks, Guide-bushings and Cam Jig used on the La Pointe Broaching Machine, Fig. 3.

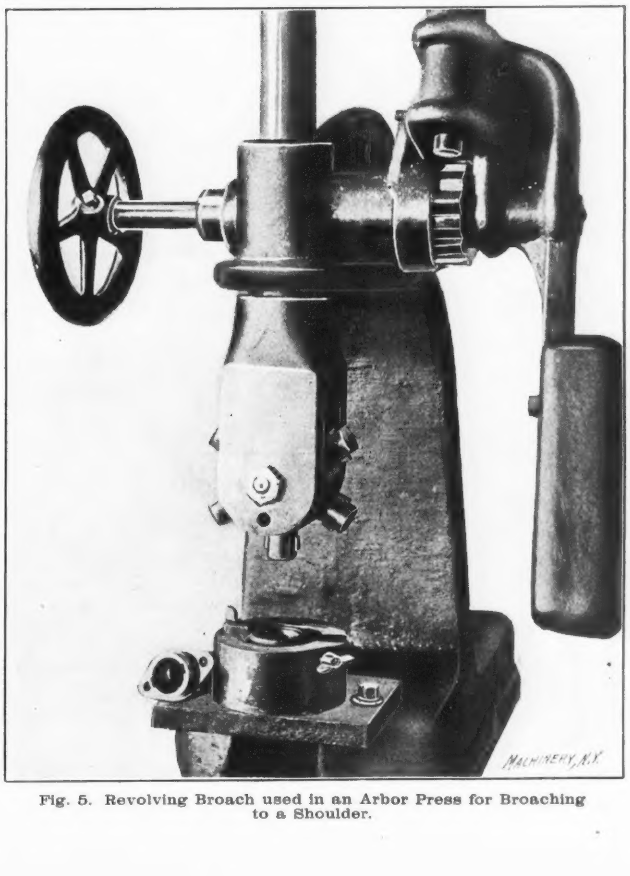


Fig. 5. Revolving Broach used in an Arbor Press for Broaching to a Shoulder.

JIGS AND FIXTURES—13.

PLANING AND MILLING FIXTURES.

EINAR MORIN.*

Fixtures for planing and milling are as essential for interchangeable manufacturing as are drilling and boring jigs. Fixtures of this kind serve primarily the purpose of locating and holding the work, but they are often provided with setting pieces or templets which are made either in one part with the fixture or separate; the cutting tools are set to

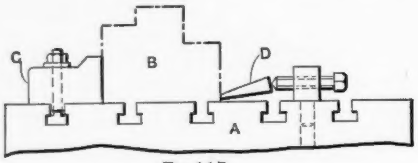


Fig.167

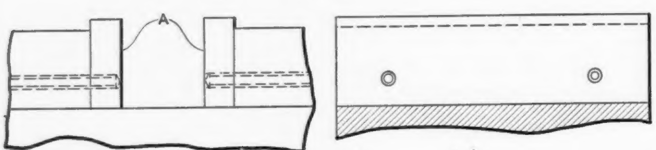


Fig.168

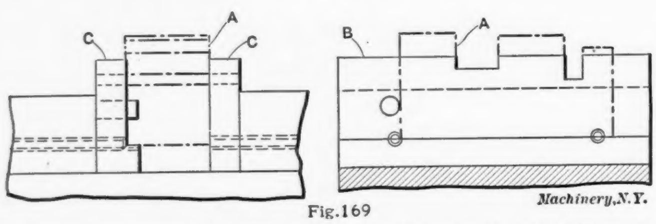


Fig.169 *Machinery,N.Y.*

Fig. 167. Principles of Fixtures exhibited by Common Method of Clamping Work on the Planer. Fig. 168. The Common Milling Machine Vise, an Example of Adjustable Fixture of Wide Range. Fig. 169. Vise with False Jaws shaped to the Form of the Work by the Cutting Tools Themselves.

these setting pieces so that the work is always machined in a cerain relation to the locating means on the fixture itself.

When more than one milling operation is to be performed on the same piece, it is often possible to use the same fixture for the various operations, but it may be, in some cases, of advantage to make up a fixture for each different operation. The designer must in this case be guided by the number of pieces that are to be machined, and the advantages as regards rapidity of handling and operation that may be gained by having special fixtures for every operation, even though the operations may be such as to permit the same fixture to be used, with or without slight changes.

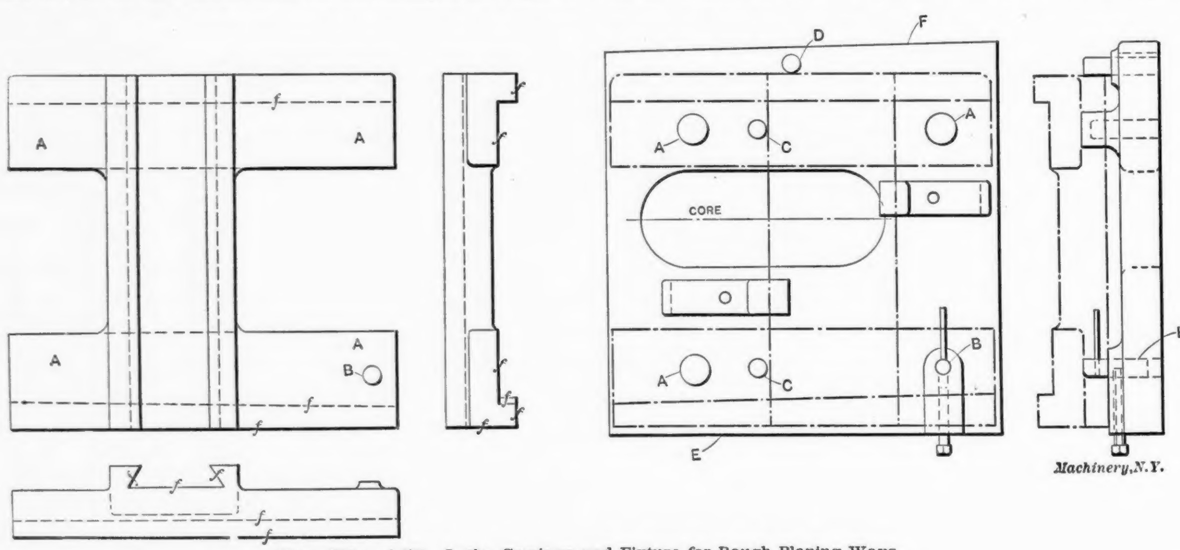
The strength of fixtures should be governed by the kind of operation to be carried out on the work while in the fixture, whether planing, milling, slotting, etc., and how much stock is to be removed. A milling fixture, as a rule, must be made stronger than a planing fixture, because a milling cutter, as a rule, takes a heavier cut than a planing tool.

The principles which have been previously explained in this series for drill jigs govern the locating means of milling fixtures, and the clamping devices of the same general type as described and illustrated in the July and August, 1908, issues of MACHINERY, are used, except that they are usually made heavier than when used for drill jigs and planing fixtures. On account of the irregular form of the work and the necessity for clearing the cutting tools, the clamps of milling and planing fixtures must often have irregular shapes.

An important factor, on which too much stress cannot be placed, is the necessity of having sufficient clearance for the cutting tools so that they do not interfere with some part of the fixture and clamping devices, and also that the fixtures, when located on the platen or machine table do not interfere with any part of the machine, when the table is fed one way or another. As a rule, milling and planing fixtures are provided with a tongue or key in the base, for locating them on the machine table. Suitable lugs should also be provided for clamping the fixture to the platen.

One of the very simplest types of fixture is illustrated in Fig. 167; work being planed is very commonly located and held by the means indicated, and for taking light cuts in the milling machine such an appliance may also be used. In this case, the planer platen *A* forms part of the fixture, and the work *B*, located on the platen, is held up against the bar *C*, which is held down by bolts, and located by a tongue as shown. The lugs and lug-screws shown with the spurs *D* hold the work up against the bar, and press it flat against the table. Instead of using the loose spurs *D* between the screws and the work, it is sometimes possible to let the screws bear directly on the work, in which case the screws should pass through the lugs at an angle with the top of the table, as shown in Fig. 175. The arrangement in Fig. 167 may or may not properly be considered a fixture, but it illustrates the principles of a fixture, as it locates and clamps the work in the simplest manner.

The most commonly used fixture for planing, shaping and milling is the vise. Standard vises are indispensable in planer or milling machine work, and by slight changes they can be used for a large variety of smaller pieces. In Fig. 168 are shown the regular vise jaws *A* of a standard vise. These jaws are often replaced by false jaws, which may be fitted with locating pins and seats, and held to the vise the same as the regular jaws. They are usually left soft, and often the



Figs. 170 and 171. Lathe Carriage and Fixture for Rough Planing Ways.

milling cutter is permitted to cut out the jaw to the same shape as required for the work, as shown in Fig. 169. Vises with false vise jaws are especially adapted for milling operations, but vises are not usually employed for long work, special fixtures then being commonly made. While it is difficult to lay down any specific principles for the designing of milling and planing fixtures, it may be said that for most kinds of plain work, finished in the planer, the fixture shown in Fig. 167 is quite satisfactory. When pieces of a more complicated nature are to be machined, particularly in the milling machine, more complicated fixtures will be required.

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Assume that a set of planing fixtures for the piece shown in Fig. 170 is required. The work is a slide or carriage for a lathe. The finishing marks given on a number of the surfaces indicate where the work is to be finished. The piece comes rough from the foundry. In the first place, it must be considered which sides to locate from, and how to locate and hold the work without springing it, and in what order the operations should be performed to best advantage. Fig. 171 shows a fixture for roughing out the ways on the bottom. The slide is located on three fixed locating points A and the sliding point B. This latter is adjustable in order to enable cutting the metal in the slide as nearly as possible to uniform thickness. Sometimes, if the parts A, Fig. 170, bevel towards the ends, lugs B may be added; these can then be finished and used for locating purposes. The carriage, as shown in Fig. 171, is further located against the pins C in order to insure that the cross slide of the carriage will be square with the bottom ways. The slide is brought up sidewise against the pin D, and then clamped down in convenient places, the clamps being placed as near the bearing points as possible to avoid springing. The reason for not having the locating point D on the opposite side, is that this side must be finished at the same setting; this side, being the front side of the carriage, is finished for receiving an apron.

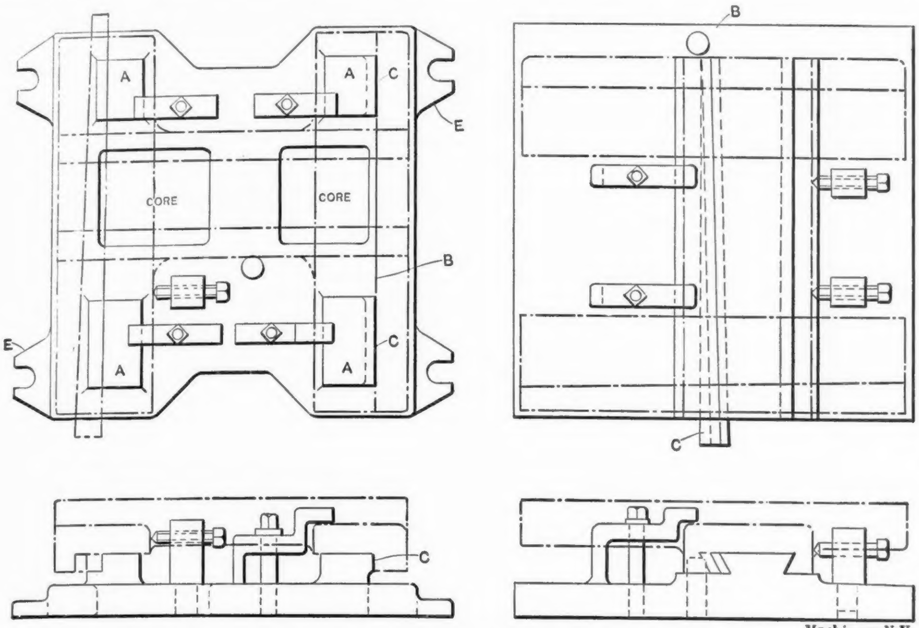
The sides E and F of the fixture may be finished in a certain relation to the locating points and each other, and the side E be made perfectly square with the locating points, so that when it is brought up against a parallel on the machine table, the ways of the machined piece will be square with the ends. The side F may be finished on the same taper as required in one way of the work for a taper gib.

The fixture for the next operation is shown in Fig. 172. This fixture is made to receive the carriage and locates it by the now rough-finished ways; in this fixture the cross-slide dove-tail in the work is planed. The slide rests on four finished pads A, and the straight side B of the ways in the slide is brought up against the finished surfaces C. If no other part is available for clamping the fixture on the machine table, lugs E are added. If there are no tapering surfaces, the fixture can be located on the machine table by a tongue, as already mentioned, or by placing a finished side against a parallel. The slide or dove-tail is now roughed out and it is usually sufficiently accurate practice to finish it in the same setting, especially as slides must anyway be scraped and fitted to suit the machine on which they are to be used.

The next operation would be performed in the fixture illustrated in Fig. 173. The carriage is here located by the dove-tail and by the pin B, and held by a gib C, or by straps and screws, as shown. It will be noticed that with the given design, the straps and screws must be removed each time a new piece is inserted, which is an undesirable feature of the fixture. If parts A in Fig. 170 project out too far, so that a light finishing cut would cause springing, they are supported by sliding points or other adjustable locating means.

If the dove-tail in the slide had simply been rough-finished in the fixture, Fig. 172, the finishing operation of the bottom ways could have been done as just described in the fixture in Fig. 173, and then, after having finished the bottom ways in this fixture, the work could again have been located in the fixture, Fig. 172, and the dove-tail finished; this procedure may insure more accurate work in some cases.

In the case just described, the work requires three different fixtures, to be completed. How many fixtures to use in each



Figs. 172 and 173. Fixtures for Planing the Dove-tail Slide and for Finish Planing the Ways of Carriage in Fig. 170.

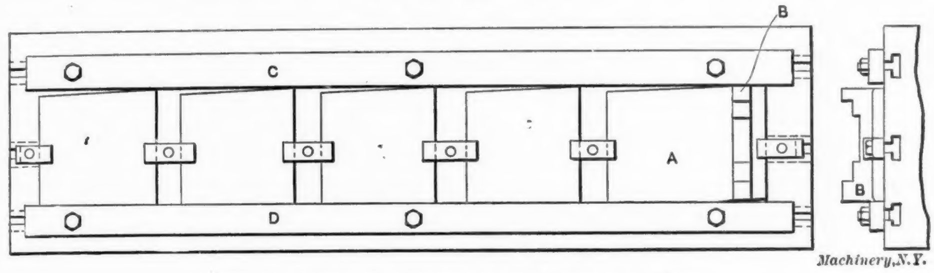


Fig. 174. "String" of Fixtures on the Platen of a Planer.

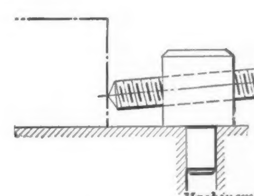
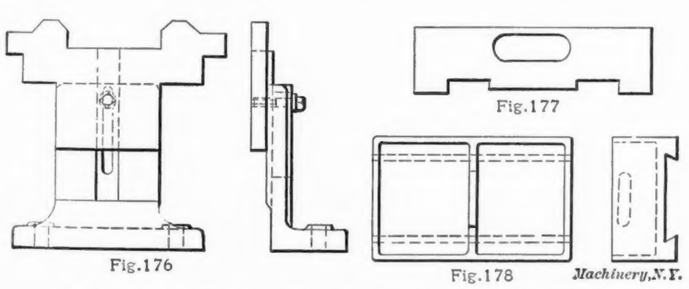


Fig. 175. Clamping Work by Means of Pointed Screw.



Figs. 176 to 178. Gages for Setting Tools and Testing Work.

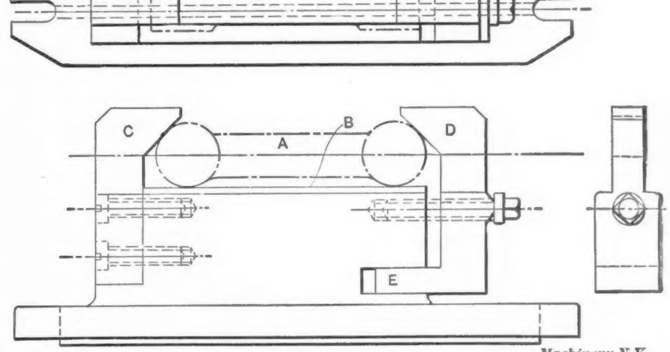


Fig. 179. A Typical Milling Fixture.

case is entirely dependent upon the nature of the work. When there is a large amount of work of the same kind to be done, several fixtures of the same type are made up for the same piece, and when in use these fixtures are placed in a "string" on the table of the machine, as shown in Fig. 174. Each strap holds down two of the jigs, one on each side of the bolt

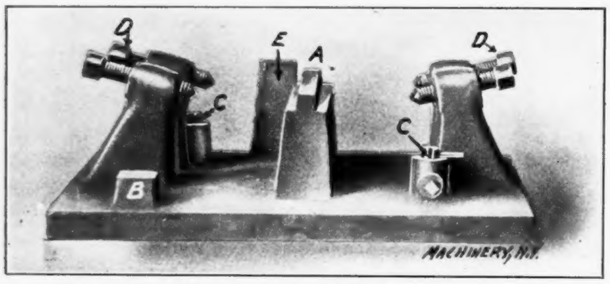


Fig. 180. Simple Type of Milling Fixture.

through the strap. The first one of the fixtures, *A*, is provided with a templet *B*, to which the tool may be set. The fixtures are located against the bars *C* and *D*, alternatingly, depending upon whether the straight or tapered side of the slide planed in these fixtures is being finished.

Templets are often made up separately, and are used to determine the machining of both larger and smaller work. A templet may even be made adjustable, as shown in Fig. 176. This templet may be fastened to the machine table either in

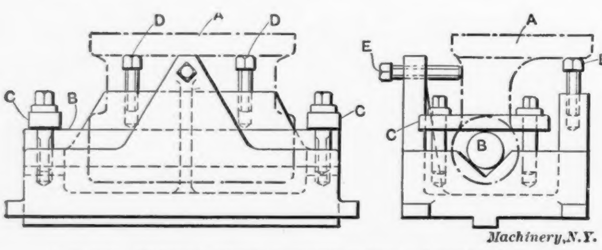


Fig. 181. Milling Fixture in which Work is Located from a Previously Bored Hole.

front or behind the work and the tool set to it, and is used when planing machine beds. Other templets or gages are made for testing the planing. They may not properly be considered as parts of the fixtures, but are usually designed and made at the same time as the fixtures are completed. These gages are made from sheet iron, and the profile or cross-section of the work to be planed or milled is cut into the templet, as shown in Fig. 177. Other testing pieces may be made up more elaborately, as shown in Fig. 178. These latter are also used for testing when scraping and fitting the work. One templet may be made for rough planing or milling and one for the finishing cut.

A milling fixture of a type commonly used is illustrated in Fig. 179. The work *A* is supposed to be milled on both sides simultaneously. It is located on the fixture base *B*, and is held up against the half V-shaped piece *C*, which is stationary and held to the base by screws; the clamping is done by a clamp *D*, which is guided at *F* as indicated, so that it has a tendency to hold the work down well. Both the clamp and the corresponding piece *C* are thinner than the work, so as to allow the straddle milling cutters to pass over the fixture without interference.

In Fig. 180 is illustrated a simple fixture which may be used for both milling and planing. Two pieces are machined at the same setting in this fixture, and are located against the finished seats *A* and *B*, which latter acts both as a seat and as a stop. Another seat like *B* on the opposite side is not visible in the illustration. As the work to be done is of a rough character, sliding points provided at *C* give an adjustable support. The work is clamped by the pointed screws *D*. The tool is set by the lug *E*, which is cast solid with the fixture and which has a top finished to the required height.

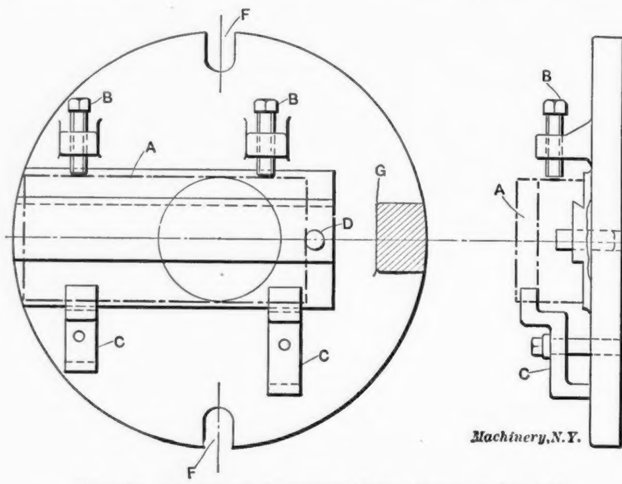
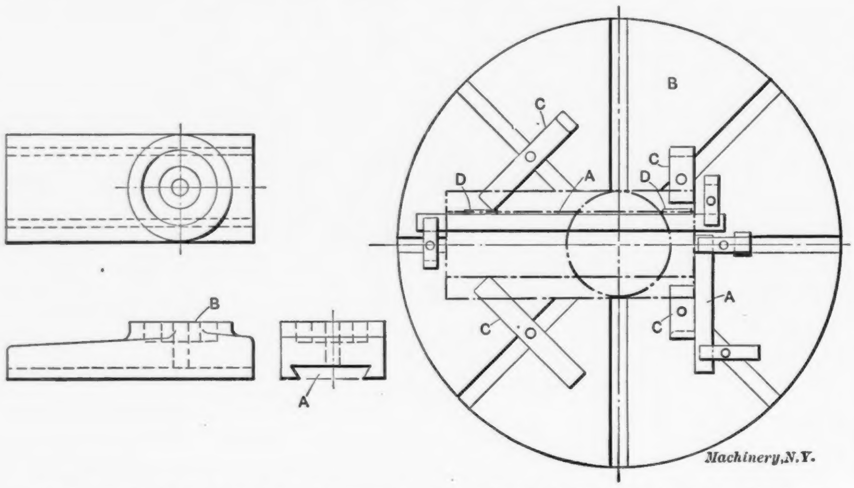


Fig. 185. Fixture for Recessing Work shown in Fig. 182.

It is often advantageous to perform milling operations after the boring and drilling has been done on the work, and then some finished hole may be used for locating the work. An example of this is shown in Fig. 181 where the work *A* is located by an arbor *B* passing through the finish-bored hole in the work, and resting on two V-blocks planed out in the fixture as shown. Two straps *C* hold the arbor down in the V-blocks. The work is further located against the screws *D*, which are adjustable so that the work may be held level. The clamping screw *E* holds the work against the screws *D*.

It is sometimes advantageous to make fixtures for holding work in the lathe. Suppose that a piece to be finished has the appearance shown in Fig. 182. The dove-tail *A* is finished, and the circular seat *B* is to be turned afterwards so that the center of the seat will come in a certain relation to the dove-tail and a certain distance from the end. This operation can be carried out as shown in Fig. 183, by placing parallels *A* on the face-plate *B* of the lathe.



Figs. 182 and 183. Work to be Recessed and Faced and Method of Doing it in a Lathe.

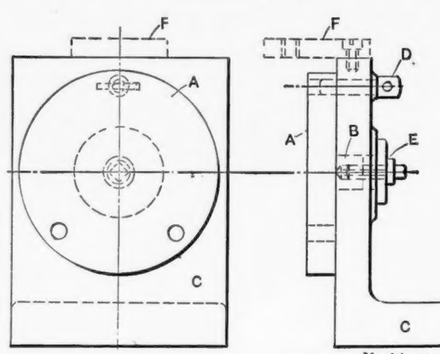


Fig. 184. Simple Type of Indexing Fixture.

These parallels will serve as locating means, and straps *C* hold down the work. If it is required that the seat be in exact relation to the dove-tail, two rollers *D* may be used onto which the slide is hooked; the angle of the dove-tail and the diameter of the rollers are calculated so that the work can be very carefully located.

The work may be turned out properly by this means by a careful man, but there are always chances of moving the parallels and it is a slow operation. If a simple fixture like

the one illustrated in Fig. 185 is used, an apprentice can do the work correctly, provided he knows how to run a lathe. The work A is located by a dove-tail in a similar manner as it later on will be located on the machine on which it is to be used. It is held against the dove-tail in the fixture by screws B and clamped down on its seat by straps C. The pin D locates the work in the other direction, and the fixture itself is located on the face-plate by the boss E; as this boss has a perfect fit in a recess turned out in the face-plate, it must, by necessity, run true. Slots may be provided for locating the fixture on the face-plate and driving keys inserted. A sufficiently large lug G may be provided for counter-balancing.

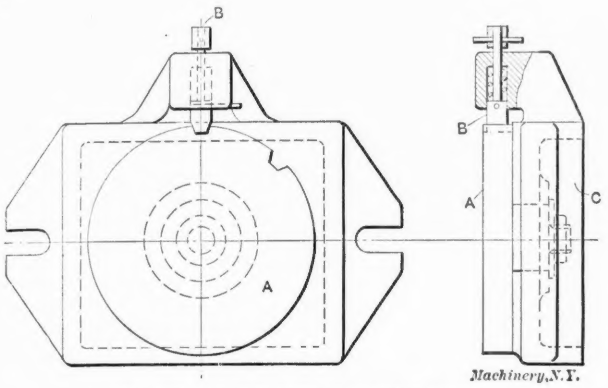


Fig. 186. Another Type of Indexing Fixture.

It is always of advantage to try to locate work in fixtures in the same manner as it is located on the machine where it is to be used.

Indexing Fixtures.

A number of fixtures for performing various operations are fitted with indexing devices, so that accurate machining at predetermined places in the work may be carried out in the shortest possible time. A simple indexing fixture is shown in Fig. 184. The work is mounted on a disk A, which turns in the bearing hole B bored out in the knee or angle iron C, which is located and fastened on the machine table. The disk A is indexed, and held in the right position by a pin D, which fits into a finished hole in the angle iron and also into one of the holes in the disk. The disk A is clamped against the knee C by a screw and washer E while taking the cut. When the main parts of this fixture are made of cast iron it is sometimes the practice to put lining bushings of tool steel in the indexing holes to prevent them from being worn out too rapidly by the continuous removal and insertion of plug D. This is a very simple indexing fixture, but a great deal of work can be finished with no more elaborate arrangements. By adding a plate F, screwed to the top of the knee, and fitted with a drill bushing as indicated, drilling operations may be performed in the same device.

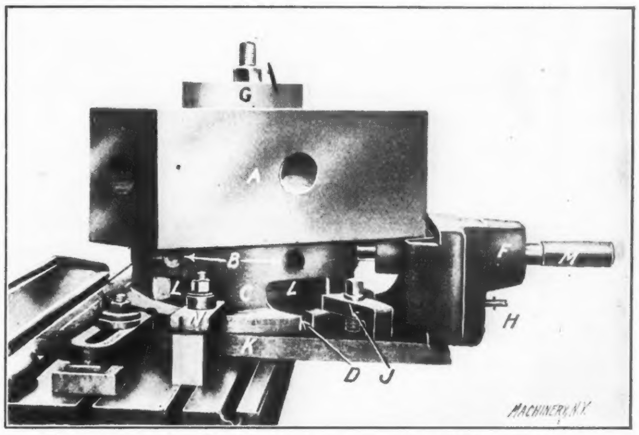


Fig. 187. A Combination Boring, Planing and Milling Fixture.

In Fig. 186 is shown a similar indexing fixture somewhat modified. The work is located and held on the rotating disk A, which is fitted in place in the bracket or body C, so as to have no play. The round plunger B is beveled on the end, and fits the slots in the circumference of the disk. A spiral spring pushes the plunger into place. The plunger is guided by a pin in an oblong slot, so as not to turn around. Sometimes the plunger may be made square or with a rectangular section, and fit a slot which may be shaped to this form. This latter method is more expensive and does not give better satisfaction than the plunger with the round body.

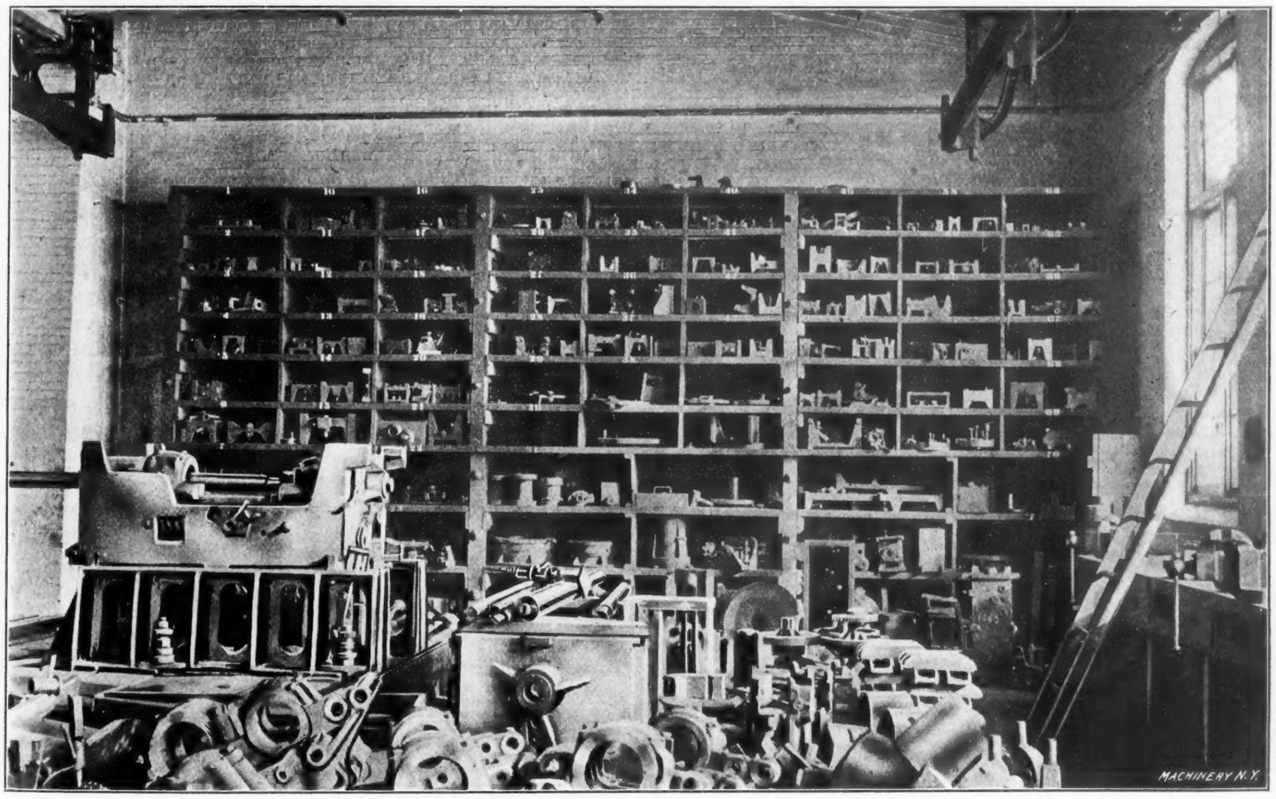


Fig. 188. An Example of Neatly and Conveniently Stored Jigs and Fixtures.

A large variation of methods for indexing are in use, employing pawls, levers, springs and safety locking devices, which sometimes may be necessary. Indexing fixtures, however, designed according to the simple principles laid down above, will give as good service as many complicated arrangements. These indexing devices are used in cases where the standard indexing heads would not be suitable, and for many classes of work are equally efficient.

In Fig. 187 is shown a fixture which serves several purposes. The work, a turret A, has holes B bored out, the sides planed and the T-slots milled on the sides, all operations being performed by using the same fixture. When boring out the holes, the turret is mounted on the circular way of the revolving part C of the fixture. The work is located in right relation to the indexing notches D by a taper gib placed in the cut-out portion of the upper part of lug F; this gib locates the side of the turret square to the bushing hole passing through the lug. This taper gib is removed after the turret is clamped down securely by the strap G on the top of it, to allow indexing by the pawl H which fits into the notches D. As will be seen in the illustration, straps J hold the rotating part C securely to the face-plate K to prevent vibration during the boring operation. The lug F which holds the guiding bushings for the boring bars and also the indexing pawl, is cast in one piece with the face-plate. The casting is cored out at L for the purpose of removing the chips as well as making the indexing plate lighter without weakening it too much. When the fixture is used for planing or milling the turret, a special plug M is used, which fits the guiding bushings and the finished holes in the turret to insure perfect alignment.

Conclusion.

In a large shop with a great number of jigs and fixtures, it is quite difficult to keep them in proper order, and to have them so indexed and classified as to be able to find the required fixture at a moment's notice. It is unquestionably the best way to permit each department to have a storing place for all its own jigs and fixtures, more especially so if there is a store-room for other tools in each department. The jigs or fixtures are given out to the operators in exchange for checks, and before they are returned they should be carefully cleaned and the finished surfaces greased to prevent rusting. Before returning the check to the workman, the tool-room clerk should look over the fixture to see that no loose parts are missing, and no parts broken, and also that all loose pieces are tied together and attached to the jig body. An excellent method for storing jigs and fixtures is shown in Fig. 188. The tools are placed on shelves partitioned off and numbered and an index is kept showing at a glance the location of the tools for different operations. A copy of the index should be in the possession of the foreman, and also of the tool-room clerk, and should give the piece number of the work to be done in the jig, the number of the jig itself, and its place in the racks.

It will be seen from the half-tone that the lighter jigs are placed on the top shelves and the heavier further down. This not only permits a lighter construction of the storing shelves, but also makes it more convenient for the attendant to put the jigs and fixtures in place. If possible, jigs used for the same machine, or the same type of machines, should be in the same section of the rack, as this, to a certain extent, facilitates the getting out of jigs for the same work. When a jig or fixture needs repairing, it should be sent at once to the tool-making department, even if it is not to be used immediately.

In some trade journals there has been a great deal of paper wasted discussing what position a tool and jig designer really occupies; whether he should be considered a designer with a designer's salary, or simply a draftsman; and of other topics of similar nature. The fact remains, however, that a progressive manufacturing plant, in order to have suitable and efficient tools devised, requires a man who possesses in the first place good shop experience, in the second place sound practical judgment, and in the third place, a fundamental knowledge of theoretical mechanical principles.

* * *

The first aeronautical exhibition of any real importance has just been held in Paris. All the French models of aeroplanes were shown, including the new Santos Dumont flying machine, which is of rather interesting construction, and of particularly small dimensions. It is proposed to hold a large aeronautical exhibition in Frankfort a. M., Germany, next year.

PUNCH AND DIE FOR CORRUGATING THIN COPPER SHEETS.

A. L. MONRAD.*

The accompanying illustrations show a punch and die designed for forming copper corrugations from 0.010-inch copper sheets. The corrugations are bent in on the sides, and when completed present an appearance as shown in Fig. 1. They are then cut apart in suitable lengths and placed on top of each other, soldered together, and used for automobile cylinder cooling arrangements. These corrugations are formed by passing a copper sheet 3¾ inches wide between the punch and the die, shown in Fig. 2, feeding the strip of copper sheet along one step or corrugation for each stroke of the press. It will be noticed from the end view in Fig. 2 that it takes five strokes to complete the operations on one corrugation, although, as five operations are really performed simultaneously, one corrugation is completed for each stroke. The first stroke "breaks down" the metal, forming a half-circular corrugation. At the second stroke the section of the corrugation is formed to perfect shape, and at the same time small tools provided cut the metal at the corners of the corrugation in order to permit the edges to be bent down later

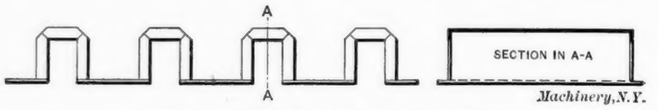


Fig. 1. Copper Corrugation to be made.

on, as shown in Fig. 1. In the third operation the ends or sides are bent over to a 45-degree angle. In the fourth operation they are bent to a 90-degree angle, a small bevel of 45 degrees, however, still being left at the inside of the bent-over end. Finally, in the fifth operation, the sides are bent up to a sharp corner. Between each of these steps the metal must be released or stripped from the punch and die and fed along one step. The stripping is accomplished by means of compressed air acting on small plungers K, which strip the metal from the punch and the die at the same moment, as soon as the punch begins to ascend. The feed is accomplished by an automatic arrangement actuated by a cam, as shown in Figs. 3 and 4. This mechanism is put in action by the descent of the ram, and locates the copper strip in an exact and perfect position. The details of the stripper and feed arrangements will be explained more thoroughly later on.

In order to prevent the punch and die from changing in hardening, it was deemed advisable to make those portions which are active in shaping the copper strips in separate parts. The manner in which these parts are inserted in the punch and die blocks is plainly shown in the end view in Fig. 2. The blocks or holders are left soft, and the hardened formers can be replaced when worn or broken, simply by driving them in place. On account of the great number of copper corrugations required, the chief feature sought in the design of the tool illustrated was to minimize the handling of the parts made, and eliminate separate operations, and for this reason an expensive tool was permissible, if efficient.

Construction of Forming and Shaping Mechanism.

In Fig. 2 is shown the front and end view of the punch and die, together with the mechanism for bending up the sides of the copper sheet, and the pneumatic stripper. The copper was ordered of the required width, and in rolls containing 200 feet of metal. These rolls were provided with large washers on each side to guide the metal, and the roll was placed in a bracket, fastened to the floor, with a steel rod through the hole in the center, on which the roll would revolve, as the copper was fed through the die. After the metal has passed through the die, it slides on a bench located at the back of the press. Gage marks are provided in the bench, and a stationary lever shear is located with its cutting surface level with the bench. The corrugated strip passes over the cutting edge of the shear, and the operator cuts off the metal to the required lengths, according to the gage marks.

The press is running continuously the whole day, at a rate of 100 strokes per minute, without any attention, the only

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thing required of the operator being to place a new copper roll on the shaft in the bracket as soon as the previous roll is used up. The metal has to be fed in by hand when starting a new roll, until a few corrugations have passed through the press. After that, the automatic feed will take care of the feeding along of the stock. While in the drawing, Fig. 2, the punch is shown considerably above the die in order to be able to show each of the parts clearly, when in actual operation the punch raises only high enough to permit the corrugated metal to pass between the punch and the die, thus guiding it on the bottom and top, while side plates guide it on the sides.

The construction of the punch and die parts are as follows: The plate *A* is of cast iron, planed on top and bottom, and fastened with four screws to the top of the platen of the press. On the top of this plate *A* is located the die block *B* fastened with four screws and two dowel pins. The die and punch blocks are made of tool steel, but not hardened. Four dove-tail slots are milled on the top of the die block for the hardened corrugating pieces *C*, which latter are ground all over and drawn to a dark straw color. In the center of the die block a 7/8-inch hole is bored to fit the shaft *D*, which operates the side pieces *L*, which, in turn, bend over the sides of the corrugations to the shape indicated in Fig. 1. This hole in the die block through which the shaft *D* passes is counterbored to a 1 1/8-inch diameter at each end. In this ond corrugation in the punch, so as not to operate on the copper plate while these corrugations are formed. Opposite the second corrugation in the die four three-cornered knives *M* are placed, which split the sides of the copper sheet in the four corners of the corrugation at the second stroke, as already mentioned, in order to permit the sides to be bent over. Opposite the third, fourth and fifth corrugations, the side plates *L* are shaped in a manner so as to bend the copper sheet first to a 45-degree angle, and then to a sharp corner, as has, also, been previously explained.

Two stop screws *O* are placed on the outside of each side-plate in order to prevent the plates from opening any more than necessary to pass the metal through; thereby the side-plates are also enabled to guide the metal while feeding. On each side of the holes for shaft *D* in the die block *B*, 1/4-inch air holes *G* are drilled the entire length of the block. One end of these air holes is plugged up with a screw, and a brass tube *H* is soldered to the other end. This tube is bent to a right angle, and a rubber hose *I* for the air supply is fastened to the outside with a brass wire. Air holes *J* are then drilled into the main channels *G*. These holes are also plugged on each end with a short screw. In the center of these holes, again, other holes are drilled, counterbored, and tapped, from the bottom of the die block for the plungers *K*, which are held down below the surface of the die by means of small helical springs. The stop screws at the bottom of the plungers

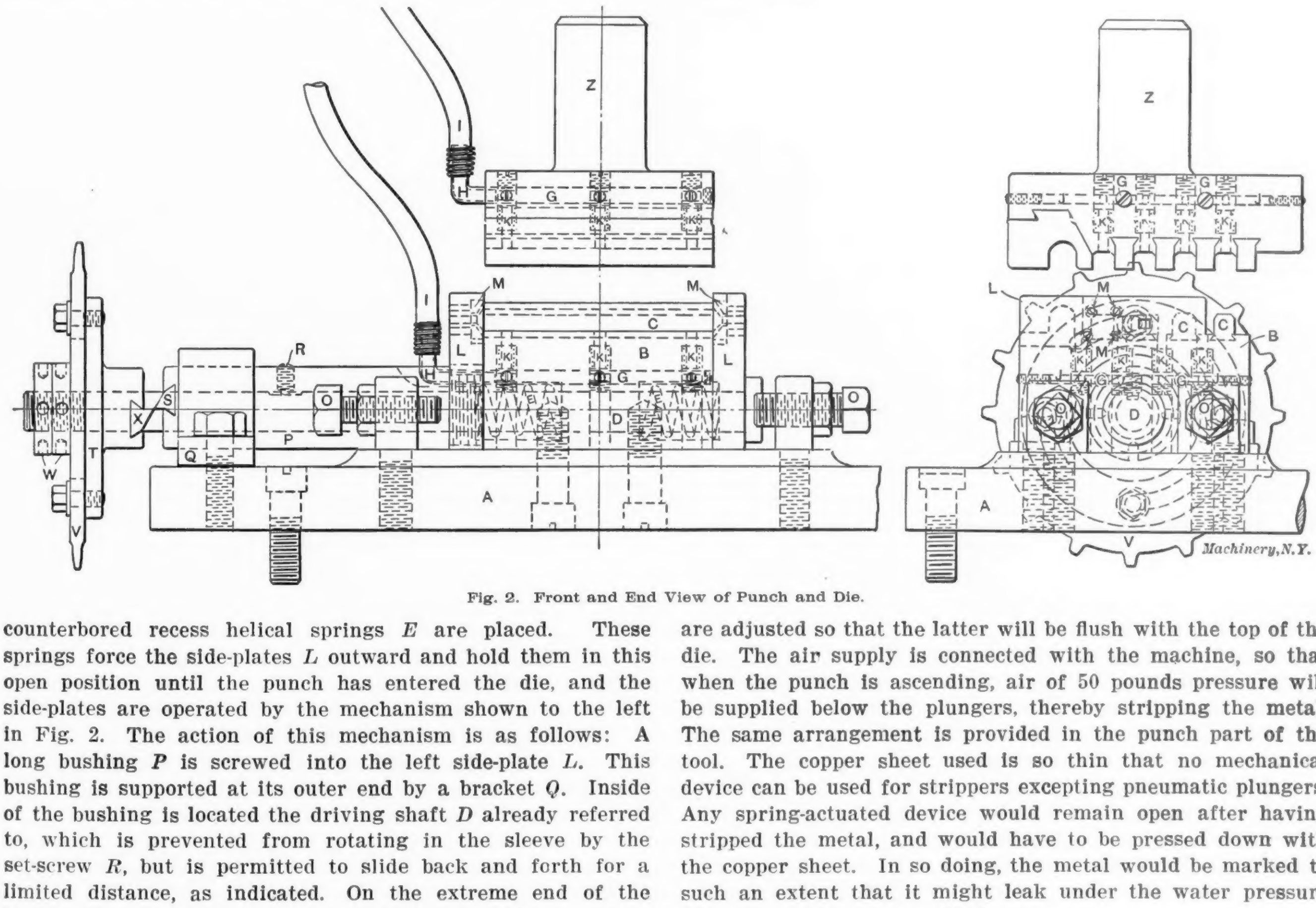


Fig. 2. Front and End View of Punch and Die.

counterbored recess helical springs *E* are placed. These springs force the side-plates *L* outward and hold them in this open position until the punch has entered the die, and the side-plates are operated by the mechanism shown to the left in Fig. 2. The action of this mechanism is as follows: A long bushing *P* is screwed into the left side-plate *L*. This bushing is supported at its outer end by a bracket *Q*. Inside of the bushing is located the driving shaft *D* already referred to, which is prevented from rotating in the sleeve by the set-screw *R*, but is permitted to slide back and forth for a limited distance, as indicated. On the extreme end of the bushing *P* a dove-tail groove is provided, into which is driven a hardened tool steel wedge *S*. On the end of the driving shaft *D* is mounted a circular disk *T*, to which is fastened a sprocket wheel *V*, held by four screws. The disk *T* turns freely on the shaft *D*, and is provided with a wedge *X* which is hardened and ground on the face. Two check nuts *W* hold the disk and sprocket in position. The sprocket wheel is driven by a chain from a sprocket placed on the press shaft, on which also is placed the cam operating the feed motion, as shown at *W* in Fig. 4. The running of the sprocket wheel is so timed that the wedges *X* and *S* will commence to operate against one another, and thereby pull in the side-plates, when the punch is about to bottom in the die. This pulling in of the side plates bends the edges of the copper sheet. The copper metal extends 1/16 inch on each side of the die. The side-plates are recessed on the side opposite the first and sec- are adjusted so that the latter will be flush with the top of the die. The air supply is connected with the machine, so that when the punch is ascending, air of 50 pounds pressure will be supplied below the plungers, thereby stripping the metal. The same arrangement is provided in the punch part of the tool. The copper sheet used is so thin that no mechanical device can be used for strippers excepting pneumatic plungers. Any spring-actuated device would remain open after having stripped the metal, and would have to be pressed down with the copper sheet. In so doing, the metal would be marked to such an extent that it might leak under the water pressure when the cooler is assembled.

Construction of Automatic Feed Mechanism.

The same press must be used at all times for this work on account of the fact that the details of the automatic feed mechanism must be fitted directly to the press, and while in operation become an integral part of it. In Fig. 3 is shown a front view, and in Fig. 4 an end view, of the automatic feed. In long dotted lines are shown the die plate, die block, sprocket and chain, in their position. The principle of the feed mechanism is that the guide hand *F* enters into the corrugation and holds it in place while the ram is descending, while, when the ram is ascending, by means of a combination of levers, the fingers *J* feed the copper strip along one corrugation. This mechanism is actuated through the cam *W* and the long lever *Q* shown in both Figs. 3 and 4.

On each side of the die are placed brackets *A*, held to the cast-iron plate *B* with two screws. On top of these brackets, on each side, are fastened guide plates *C*, which guide the copper strip. A U-shaped steel bracket *D* is fastened to the back of the ram. It is provided with a quarter-inch hole in each end, through which is passed the guide hand screw *E*, provided with two check nuts, acting as a stop when the screw comes to its downward position. The end of this screw is slotted to receive the guide hand *F* and a pin is passed through both so that the guide hand will move with the screw. The left-hand end of the guide hand *F* is connected to the end of a rod *G*. When the punch descends, the guide hand *F* follows and drops in a corrugation and locates the copper strip exactly in the correct position for the next stroke of the press. Back of the rod *G* is another stud *H*, having a link or plate attached to it with a free end. At the lower end of this link hangs a brass casting *I*. The opposite end of this brass casting is slotted, permitting the guide hand *F* to drop in. On the side of the casting *I* hang pawls or fingers *J*, being free to move around their fastening screws. When the casting *I* moves forward, being actuated through the lever *Q* one end of which rests against cam *W*, these pawls slip over the corrugation and drop into the next groove. When the casting *I* moves back again to the original position, the pawls hang down and catch against the side of the corrugation and feed the copper metal along.

To each side of the cast-iron plate *B* is fastened a steel block *K*, Fig. 3. To these blocks is fitted the cam lever shaft *L*, to which, in turn, are fitted the two feed arms *N*. These are located in position after the whole die and feed mechanism are assembled, a groove being turned in the shaft for the set-screws holding the feed arms *N* in position. On the other end of these feed arms two side plates *O* are attached. Between these plates a bushing is placed, a taper pin being driven through the bushing and the two plates. On the extreme left-hand end of shaft *L* the connecting link *P* is fastened, the other end of this link being connected to the cam lever *Q*, which is attached to the left side of the press by a screw *R*, holding it to the bracket *S* which in turn is attached to the press. The other end of the cam lever is bent to an angle of 45 degrees with the horizontal, and works against the cam *W* which is fastened on the press shaft together with the sprocket wheel which drives the sprocket wheel for the shaft *D* in Fig. 2. A long spiral spring *T* is attached to the end of the lever *Q*, and is connected on the other end to a rod *V*, which is fastened to the extreme end of the side of the press. A stop is provided for the cam lever by placing a bent steel plate *Y* on the left side of the press in the front as shown. The stop screw is provided with a head, against which the lever *Q* will stop. The other end of the screw is provided with a check nut to hold it in place. This arrangement has proved very satisfactory for carrying out the work for which it was intended. It looks rather complicated on the drawings, but in reality it is simple, and contains no superfluous parts.

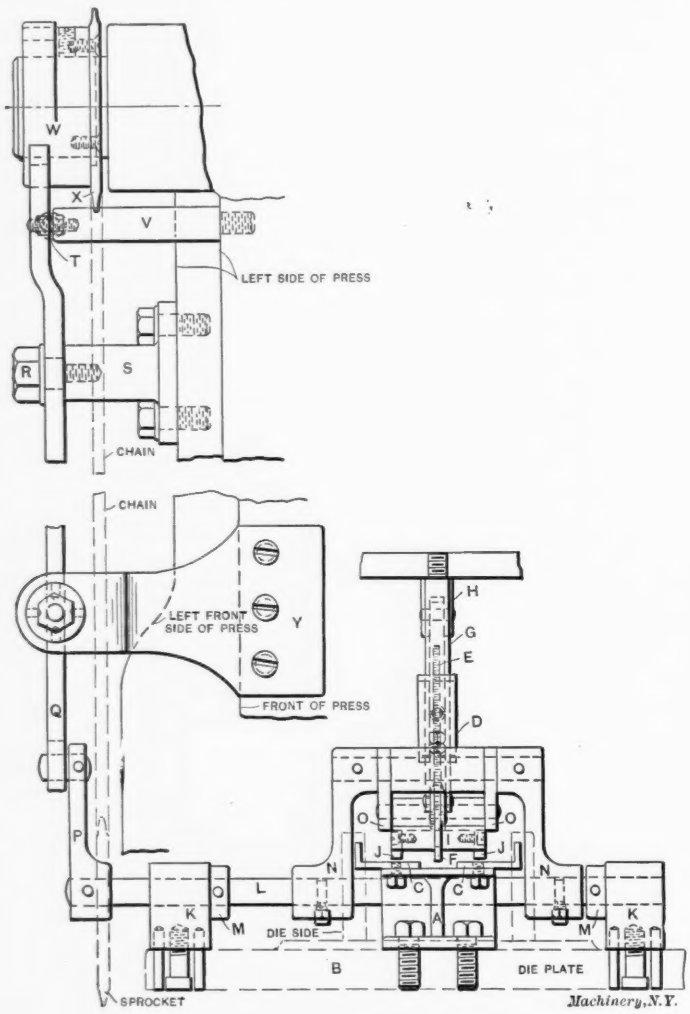


Fig. 3. Front View of Automatic Feed Mechanism.

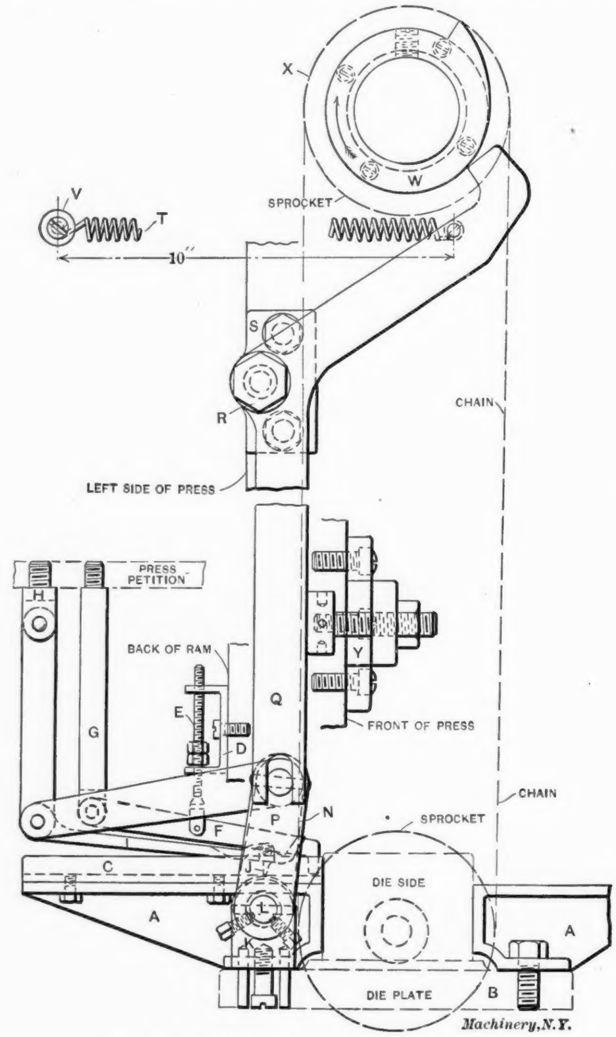


Fig. 4. End View of Automatic Feed Mechanism.

* * *

The police department of New York City is said to be considerably excited by the moving pictures shows which illustrate how safes are dynamited and robbed by safe-crackers. The pictures illustrate vividly and true to life how a safe is covered with blankets to deaden the sound of the explosion, and the robbers looting it when the door has been blown off. The vividness of the illustration and accuracy to detail make the process so plain that the tyros in crime need no further instruction to become safe robbers. No doubt the suggestiveness of these illustrations is powerful and dangerous. In the March issue we spoke of the effectiveness of the moving-picture machine in education, and in the January issue suggested that it could be used very profitably in teaching a trade. If the machine can be made a powerful incentive to crime, it surely can be made equally powerful as an incentive to industry by illustrating processes and manipulations that honest young men are eager to learn and understand.

THE FORGING OF HOOKS AND CHAINS.*

JAMES CRAN.†

Most of the available information relative to hooks and chains is of a technical nature, and is better suited to meet the needs of the designer and draftsman than the blacksmith. There are given numerous tables of dimensions, and sizes, angles, etc., for finished hooks, but no information or rule seems to have been published whereby the blacksmith may arrive at a definite conclusion as to the diameter and length of material to use for hooks of different capacities. This condition has been responsible not only for a great deal of guess work, but also for the existence of poorly-constructed

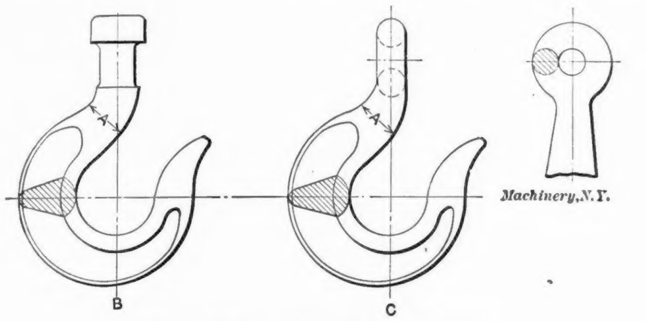


Fig. 1. Two Common Types of Crane Hooks.

and very unsatisfactory hooks, which generally have required more time and material to make than necessary. When hooks of either of the types shown at *B* and *C*, Fig. 1, are to be forged, stock of the diameter *A* of the hook should be used. If a hook is made in proportion to a chain to which it is to be attached, the easiest and simplest method of determining the right diameter of material to use is to multiply the diameter of the material of which the chain is made by 2½. For obtaining the length of the material for the hook, multiply the diameter by 7. Take for example a chain of standard pattern made from material ½ inch in diameter, which is generally recognized as the correct size for a working load of 1½ ton; then ½ inch × 2½ = 1¼ inch; 1¼ inch × 7 = 8¾ inches; therefore 8¾ inches of material 1¼ inch in diameter is the right amount of stock to use for a hook that will take a working load of 1½ ton. If properly forged, a hook made from this material will be in accordance with the tables of dimensions generally given for crane hooks.

Swivel hooks up to 3,000 pounds capacity are made from the end of a bar which ought to be cut the right length to permit the making of a certain number without waste. The first operation is to taper the end of the bar for the point of the hook as shown in Fig. 2. Where there is a power or steam hammer this is done by means of spring swages made with a taper impression as shown in Fig. 4. A suffi-

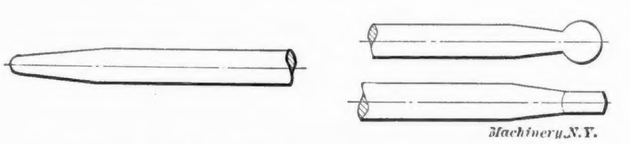


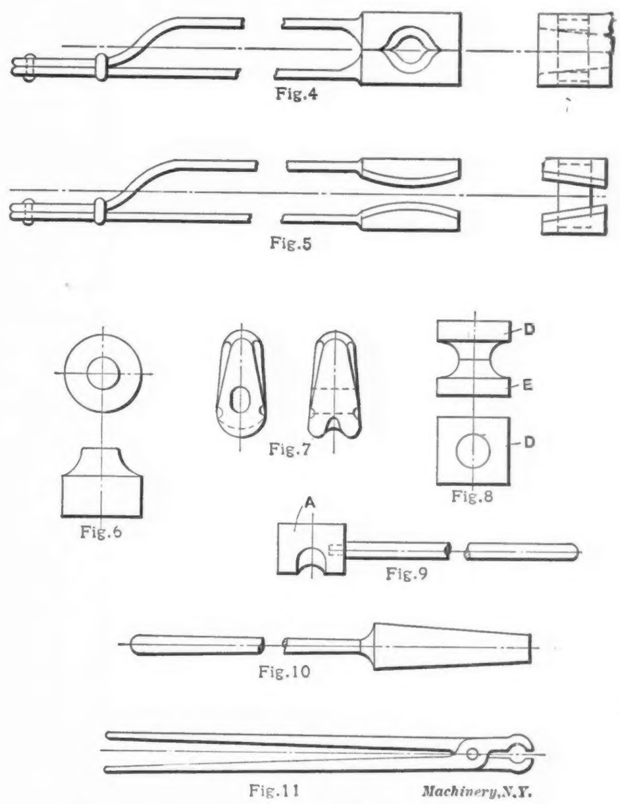
Fig. 2. Tapering the End of the Bar for the Point of the Hook.

Fig. 3. Tapering and Shaping the Upper End of an Eye-hook.

cient length of the stock for one hook is then heated and bent to about two-thirds of a circle by using a bending device similar to, but heavier than, that shown in Figs. 7 and 8 in an article entitled "Tools for Increasing Production in Blacksmith Shops," in MACHINERY, November, 1908. After the hook is bent, it is removed from the bending device and is tapered or "fished" on the back at the same heat, by using tapering tools made on the same principle as spring swages, and shown in Fig. 5. The faces are slightly convex lengthwise, and the edges well rounded off to prevent leaving marks on the work. As the back of the hook is tapered, it is drawn a little on the outside; this closes it sufficiently, so that but very little finishing or truing up by hand is necessary. It is now ready to be separated from the bar. Material for heavier swivel hooks, and all sizes of hooks to be made with eyes, should be cut in lengths that will each make one hook. The reason for this is that swivel hooks over 3,000 pounds capacity would be too stiff and heavy to be bent by a hand bending device, and hooks with eyes must be tapered at both the neck and the point.

Eye hooks can be tapered at both neck and point with the same swages as are used for tapering the points of swivel hooks. The first operation in making eye hooks is to taper the neck, after which the portion for the eye should be flattened down to about half the thickness of the material used, and roughly rounded as shown in Fig. 3. The hole for the eye is then punched, the blacksmith removing as little stock as possible and drifting until the hole is large enough to admit of tools of the style shown in Fig. 6 being used to finish the inside to a half circular section. These tools are used in pairs; one tool is placed upon the lower die of the steam hammer, the eye of the hook fitted over it, and the other tool is inverted and placed on the upper side of the eye. Two or three blows of the hammer practically finishes the inside of the eye.

The outside is finished at the anvil by using another tool of exactly the same shape as that shown in Fig. 6, but



Figs. 4 to 11. Tools used in Forging Hooks and Chains.

provided with a shank to fit the square hole in the anvil. A short swage, the face of which is radial and having a circular impression well backed off at the edges, as shown in Fig. 7, is used to smooth the outside as the eye rests on the tool in the anvil. When this is done, the point is tapered and the hook is ready for bending, which on the smaller sizes may be done at the anvil without special tools; but large sizes of both types can be more easily and quickly bent at the steam hammer by using the former shown in Fig. 12 to start the bend. The body of the former is of cast iron, with a steel wedge or binder. Hooks to be bent are heated all over; the portion for the shank of swivel hooks is placed between two V-blocks *C* which are made to fit between the lugs of the former, and are held firmly in place by wedge *B*. A steel block *A*, Figs. 9 and 12, the face of which is made on an arc to conform with the radius of the former, and having a circular impression the entire length of the face, is placed on the upper side of the hook, and the bend is started either by gradually admitting steam to the cylinder of the hammer and pressing the hook down as far as the former will admit, or by a series of light blows. The hook is removed

* For dimensions of hooks and chains, see MACHINERY'S Data Sheet No. 33, June, 1904, and also the Supplement with the current issue of the engineering edition.

† Address: 916 West Third St., Plainfield, N. J.

from the former, and the bending is continued until the hook is bent to about two-thirds of a circle, by placing it between the dies of the steam hammer as shown in Fig. 13. The back is tapered in the same manner as are smaller sizes, and the inside is trued up on the taper mandrel, Fig. 10. The advantage of having the mandrel tapered is that it can be used to true up different sizes. Large eye hooks are bent and finished in exactly the same manner except that instead of using V-blocks to hold them on the former, two pieces of steel made to fit the eye of the hook and the lugs of the former as shown at D and E, Fig. 8, are used.

The Forging of Chains.

It is very seldom that chains are forged by the ordinary blacksmith, apart from making a link to repair an old chain, joining two pieces together, or attaching them to hooks or rings. Most of the chains used are made by chain makers who seldom do anything else. They are generally such experts in this kind of work that they can turn out chains in less

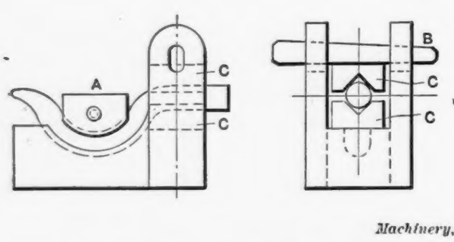


Fig. 12. Device for Starting the Bend in a Crane Hook.

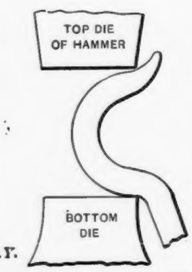


Fig. 13. Completing the Bend of the Hook.

than half the time it would take the men who only make a link occasionally. Nearly all blacksmiths, however, have to do more or less chain repairing, and it is well for them to be posted on this particular class of work. In making chains, the following dimensions will prove satisfactory for general purposes. For notation, refer to Fig. 14.

B = width of link inside = $1\frac{1}{4}$ A,
C = length of link outside = 5 A,
D = length of link inside = 3 A,
E = width of link outside = $3\frac{1}{4}$ A.

Large sizes of standard pattern chains are a trifle shorter than the dimensions given above, but for all practical purposes, the formulas given can be followed. The length of chain links inside being only three times the diameter of the

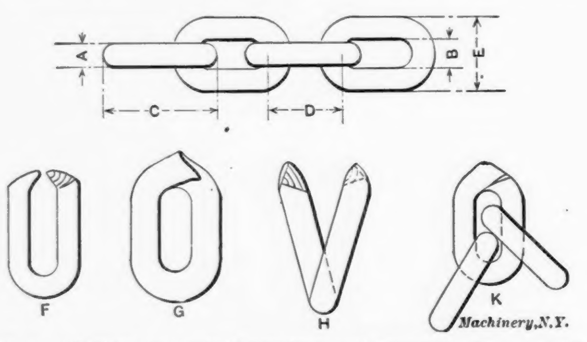


Fig. 14. Notation for Chain Dimensions, and Successive Stages in the Welding of a Chain Link connecting Two Pieces of Chain.

material of which they are made makes it rather difficult to join two pieces of chain together with a link the same length as the rest of the chain. One link of each of the pieces to be joined being placed inside the connecting link before it can be welded, leaves but very little space for holding the connecting link with tongs, and but small room for its being placed on the horn of the anvil for finishing up the end after welding. The easiest way to do work of this kind is to bend the link and scarf it as shown at F, Fig. 14; then bend the scarfed ends around and close them together as at G. After this the link should be heated all over and twisted at the lower end, as shown at H, until the scarfed ends come far enough apart to allow the end links of the pieces to be joined to pass over the ends. The ends are now twisted back to their first position and the link is ready for welding as shown at K. The link being already hot, and the end links of the chain cold, it comes to a welding temperature when placed in the fire, before the rest of the chain is affected by the heat. The tongs shown in Fig. 11 are the best kind to use either for chain making or repairing, as they take a good hold upon the work and do not cover enough of it to be in the way.

Chains used in connection with cranes or hoists for lifting heavy pieces are generally made with a hook at one end and a ring at the other; sometimes the chains are single, but quite often two, three or four chains and hooks may be attached to the same ring, according to the shape of the pieces they are intended to support. In places where a number of this kind of chains are used it will be found a good plan to give each chain or set of chains a number which should be marked upon them, together with their lifting capacity, in some place where it will be easily seen. A good way to do this is to use a large flat link made from the solid between the ring and the chain as shown in Fig. 15. The holes in the ends are punched and nicely rounded, the same as eyes for hooks. The flat space between the holes is used for the number, working capacity, or any other marks that may be necessary. Lifting chains should be annealed occasionally; by having them numbered or other ways marked it is easy to keep a record of each chain, when and how it has been repaired, when annealed, etc.

Crane hooks are often used for purposes which make it impossible to get the load in the center of the hook. The point then takes the greater part of the strain, and hooks for such service ought to be made from very heavy bar at least three times the diameter of the chain.

No definite information can be given for the rings, as the size of material to use depends entirely upon the diameter of the ring; the larger the ring the heavier the material

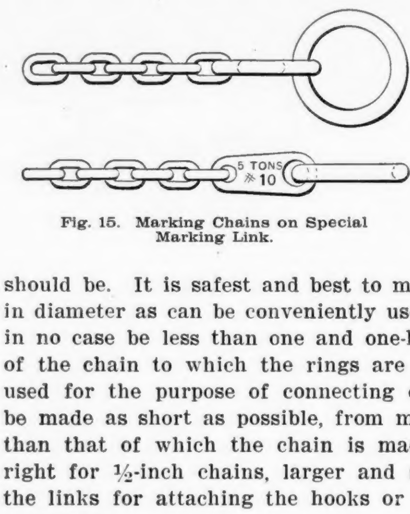


Fig. 15. Marking Chains on Special Marking Link.

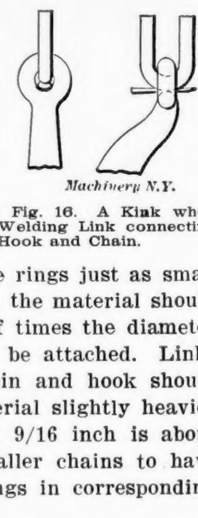


Fig. 16. A Kink when Welding Link connecting Hook and Chain.

should be. It is safest and best to make rings just as small in diameter as can be conveniently used; the material should in no case be less than one and one-half times the diameter of the chain to which the rings are to be attached. Links used for the purpose of connecting chain and hook should be made as short as possible, from material slightly heavier than that of which the chain is made; 9/16 inch is about right for ½-inch chains, larger and smaller chains to have the links for attaching the hooks or rings in corresponding proportion.

Anyone who has ever attached hooks or rings to chains knows what awkward work it is, especially if the chains are of heavy dimensions; either the hook will come in the way when welding the link next to it, or the chain will keep moving around the sides of the ring. This difficulty can be overcome to a certain extent when attaching hooks by placing the link used for the purpose in the eye of the hook and driving a wedge behind it as shown in Fig. 16. This holds the link firmly in position while the hook is held in tongs. In attaching chains to a ring, when plain links are used for the purpose, these should be left open enough at one end for the ring. Rings should be prepared for welding in the same manner as shown at F, G, H, and K, Fig. 14. In cases where more than one chain is to be connected with one ring, the different pieces of chain should be bound together with wire to prevent their moving around the sides of the ring while it is being heated and welded.

In repairing old and worn chains, material heavier than the original size of the chain should never be used, as the new link then will act as a wedge, and will put a breaking strain on the link. It is always preferable to repair with material the same size as the chain, or, where the links are

very much worn, material slightly smaller than the chain will give better satisfaction, as it will readily find a bearing in the worn ends of the links without bringing any additional strain upon them. The new links will be just as strong as the rest of the chain. It is by no means uncommon to see chains that have been repaired with links here and there throughout their length of material considerably heavier than the original size of the chain, which is a mistaken idea of making a strong job, for "chains are never stronger than their weakest link."

The best material to use for chains, hooks and rings is a good grade of wrought iron, such as Swedish or Lowmoor iron, either of which is freer from silicon, phosphorus sulphur, or other impurities than the more common brands. The tensile strength of the best grades of wrought iron does not exceed 23 tons to the square inch, while mild steel of about 0.15 per cent carbon will have a tensile strength nearly double this; but the ductility and toughness of wrought iron, which is greater than for any grade of steel, is in its favor for making appliances that are to be subjected to heavy strains and loads, as it will always give warning by bending or stretching before it fractures or snaps off.

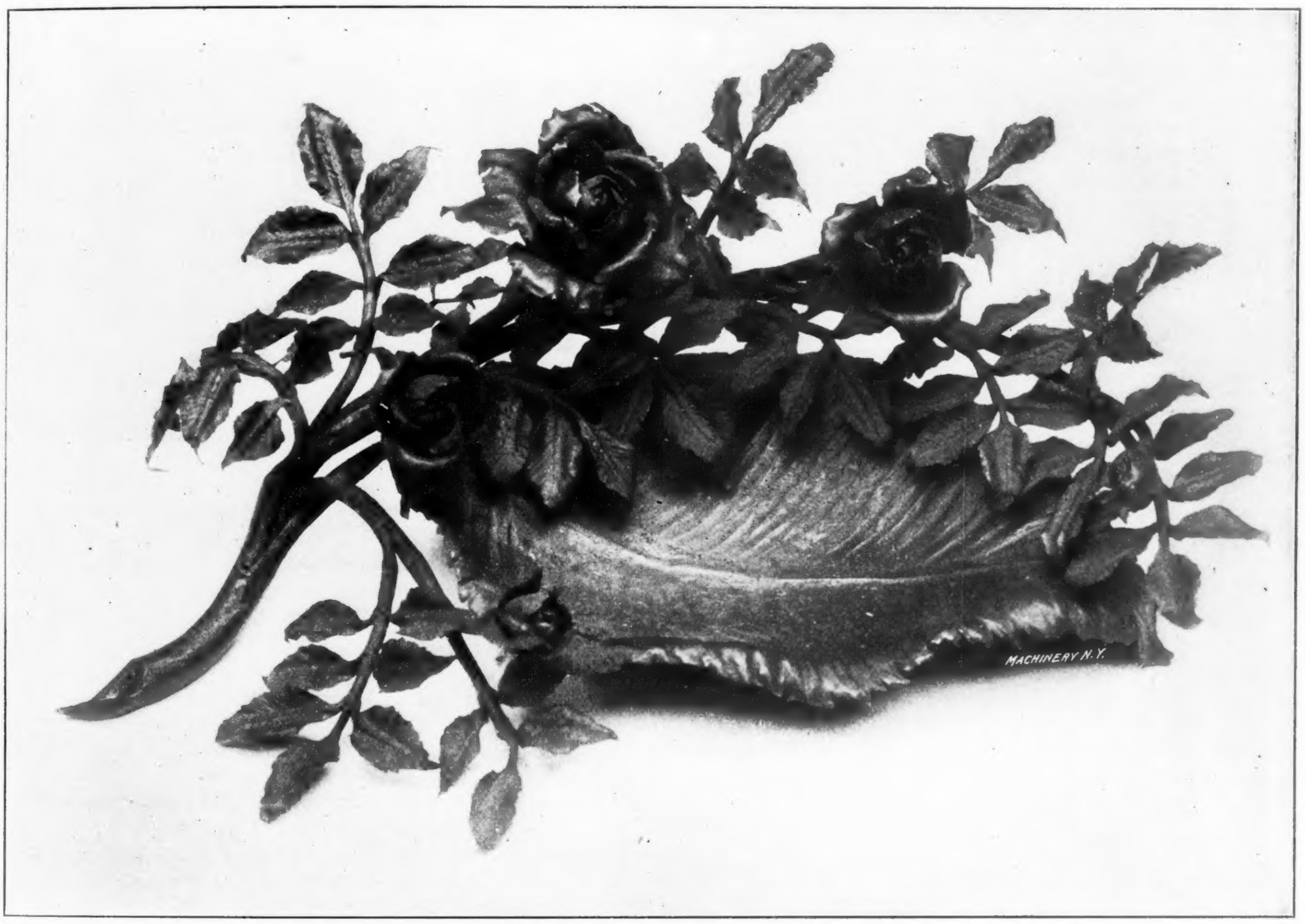
* * *

TESTS OF STANDARD CAST IRON FITTINGS.

The Crane Co., Chicago, Ill., recently made a test of standard cast iron fittings, including its own make and fittings made by seven other leading manufacturers. The fittings tested were one-inch cast iron ells, and three separate tests were made. The accompanying table shows the lowest and highest pressures at which the fittings burst, together with the average of the three tests. The tests show that the weakest fittings are amply strong enough to stand any pressure to which a cast iron fitting would ordinarily be subjected. It is unthinkable that an ordinary cast iron one-inch ell would be used in service that would require a pressure of even one thousand pounds per square inch, and the weakest fitting in the lot broke at an average of 2,500 pounds to the square inch. Cast iron fittings must be made with a great excess of strength, however, not to withstand internal stress merely, but also the blows and twisting to which they are subjected in erection and use. A valuable characteristic of

Lowest Pressure at which Castings Burst.	Highest Pressure at which Castings Burst.	Average of Three Tests.
7,300 lbs.	8,000 lbs.	7,666 lbs.
7,000 "	7,500 "	7,333 "
6,400 "	7,500 "	7,066 "
5,000 "	8,400 "	7,133 "
6,000 "	8,200 "	7,166 "
5,800 "	7,900 "	6,733 "
4,400 "	8,200 "	6,533 "
2,500 "	5,800 "	3,866 "

cast iron fittings is that when they are a long time erected and it becomes necessary to remove a section of a pipe line, it is not necessary to begin at the starting point and unscrew length by length; a cast iron fitting can be easily broken with a hammer and the desired section removed and replaced by the use of a simple right and left coupling or a union.



Tray for Letters, Cards, etc., representing a Rose Branch Hammered out of Swedish Iron, by Mr. James Cran.

* * *

MORE ARTISTIC BLACKSMITHING.

The illustration shows a piece of remarkable blacksmithing done by our contributor, Mr. James Cran, foreman blacksmith of the Pond Machine Tool Co., Plainfield, N. J. The piece illustrated is of the same general character as that appearing as Fig. 1 in the January, 1909, number of MACHINERY, but is much larger. Its length is 15½ inches, breadth 12 inches and weight 61 ounces. It represents a rose branch with three full blooming roses and two buds; and a large leaf forms a receptacle for letters, cards, etc. The forging is characterized by extreme delicacy of work and wonderful fidelity to form.

Mr. Cran's ability as an artist in this line seems the more remarkable because he had done comparatively little work of an artistic nature until within the last few months. The greater part of his experience was acquired on heavy machine blacksmithing where clean welds and plenty of stock to clean up to the required shape have been the principal considerations. We understand that Mr. Cran will establish a small shop where he will do artistic blacksmithing to order in his spare time.

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We solicit exclusive contributions from practical men on subjects pertaining to machine shop practice and machine design. All accepted matter is paid for at our regular space rates unless other terms are agreed on. All copy must reach us by the 5th of the month preceding publication.

APRIL, 1909.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 650 reading pages and 36 Shop Operation Sheets, containing step-by-step illustrated directions for performing 36 different shop operations. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, including Shop Operation Sheets, and about 250 pages a year of additional matter, which includes a review of mechanical literature, and forty-eight 6 x 9 data sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. RAILWAY MACHINERY, $2.00 a year, is a special edition, including a variety of matter for railway shop work—same size as Engineering and same number of data sheets.

SIZES OF ILLUSTRATIONS.

The illustration of a machine or tool should show as clearly as possible the details of construction that are of general interest to the reader. If a machine is large, but simple in construction, it obviously does not require a large illustration to make its purpose and form apparent. On the other hand, a small machine that is not larger than a typewriter, may be so complicated and contain so much mechanism that it requires a larger illustration to show its design clearly than a massive planer weighing a thousand times as much. There really should be no comparison made of the actual sizes of illustrations, as it is the detail of each machine itself that determines in the editor's mind what size the illustration shall be.

We speak of this because of the supposed incongruity of illustration sizes that is found in these pages, particularly in the department "New Machinery and Tools" where a massive planer or milling machine is often shown on a comparatively small scale, while a screw tap or other small tool is shown much nearer its size. It is obvious to even the inexperienced that it would be impossible to show the two devices in their actual relative proportions: for if the tap illustration were made so small as to be barely distinguishable, the planer engraving would still be larger than could be spread on two pages. This fact is so simple and obvious that it is surprising that some of our friends have occasionally expressed dissatisfaction because the illustrations of their products were not as large as, in their opinion, the importance of the machine merited. We cannot be governed by considerations of mere size, but rather by the details of each case, and this is the rule by which all illustrations appearing in MACHINERY are made.

* * *

ETHICS OF ENGINEERING PAPERS.

Considerable trouble has been made in the American Society of Mechanical Engineers by the presentation of papers in which the author has quoted results of tests of his company's machines and competitive machines, to the discredit of the latter. Naturally the concerns whose machines have been put in an unfavorable light have taken exception to these papers. The situation is a very difficult one for the management of the society. It is absolutely necessary that papers on live commercial subjects be presented if the society is to live and prosper, and unless papers can be presented recording the results of tests made by mechanical engineers to determine relative economies, one of the best fields for papers will be shut off.

The society is not so situated that it can undertake on its own initiative extensive tests of various mechanical apparatus for the purpose of determining relative efficiencies and defects that should be corrected. It of necessity depends on the individual initiative of various manufacturers and the willingness of these manufacturers' mechanical engineers to report to the society the result of investigations.

A suggestion that has been made which seems worthy of consideration, is that whenever tests of competitive apparatus are to be undertaken by any concern, it should in courtesy invite representatives of the competing concerns to be present, and one or more disinterested engineers to act as referees. A report of the tests made under such conditions could consistently be presented before the society without unfairness to one concern. We hope that we shall not lose the benefit of such investigations made by engineers, and that reports can be made under substantially the conditions set forth. This would be to the material advantage of the society and the engineering profession as a whole.

* * *

NEW HIGH-SPEED STEEL.

The steel makers of Sheffield are reported to be greatly exercised over the published announcement of the "discovery" of a new high-speed water-hardening steel having from three to eight times the capacity of the high-speed steels now in common use. Knowledge of the wonderful new steel appears to have been common among the leading steel makers of Sheffield, and it seems that there was a tacit understanding to keep its existence secret until the existing stores of high-speed steel were used up. The steel makers of Sheffield in effect rebuked Prof. Arnold of the Sheffield University for his address delivered before the Royal Institution in which he announced the steel; and in a published protest they pointed out that the statement has caused the countermanding of orders for the old quality of high-speed steel, and serious losses of business have resulted.

The discovery of a water-hardening steel of even fifty per cent greater capacity than the old high-speed steels would represent a great advance, but what shall we accomplish with a steel from three hundred to eight hundred per cent higher capacity? We infer from the gossips of agents in this country that the increase of capacity is in the lasting qualities rather than in the feed and speed. A lathe tool that would stand up for, say, one hour and thirty minutes' heavy work when made of the older form of steel, will last a day or a day and a half in the same service when made of the new steel. The saving of time in grinding lathe tools is not of great importance, perhaps, but for classes of tools that require to hold a given size for long service, as in the case with reamers, boring tools, drills, automatic screw machine cutters, etc., the value of a high-speed steel of such lasting quality can scarcely be overestimated. It is probable that the new steel also has greater feed and speed capacity than the older steels.

The increased durability of the new steel is due, of course, to its ability to stand up under a higher temperature than the ordinary high-speed steel. The characteristic of "red hardness" is strongly pronounced at a temperature that would destroy other high-speed steels when cutting heavy chips. This characteristic enables a tool to be ground with a sharper angle, and the sharper angle reduces power consumption, generation of heat, and stress on machines. It is possible that the actual superiority of the new steel as regards the red hardness characteristic, is not much greater than of the other steels, but a slight increase which enables a sharper angle to be employed materially reduces heating and vibration, and these advantages being cumulative make a great increase of efficiency and durability.

The question that occurs to everyone concerned with the manufacture and design of machine tools is: "What next?" What will be the effect on machine design and shop organization? We have by no means yet realized the full capacity of the Taylor-White steels, and the discovery of a new steel of far greater capacity still further widens the gap between the steel maker and the machine shop organizer and tool designer. It is not too much to say that the discovery of high-speed steel was one of the greatest of modern times; and to have the value of the discovery more than quadrupled at one stroke, opens a vista of mechanical possibilities that causes past mechanical achievements to appear almost insignificant. It means so much for the advancement of manufactures, arts and science that the mind cannot grasp it.

* * *

THE APPRENTICESHIP PROBLEM.

The following letter, written by a well-known machine tool builder, describes the difficulties of training apprentices under present conditions and the typical methods followed in many American works (excepting the three-year contract feature) to train workmen. It is an old and well-known story, and our reason for publishing the letter is that it concretely illustrates a phase of our manufacturing development that has been wonderfully successful in production at low cost, but which, in the opinion of many, is a menace to our manufacturing supremacy, especially in the machine tool building business. If this industry cannot educate the force that will direct its future work, it will fall behind because of the lack of men trained to be resourceful and inventive, and comprehensive of the business in all its phases:

"In reply to your letter of a recent date with reference to instruction of apprentices, would say that we do not have any apprentices in our works, having discontinued this branch of our help some two or three years ago for the following reasons:

"First, our experience has been that there are only about 40 per cent of the boys that we had in hand that ever completed their course, the majority of them leaving about the beginning or during the second year. The principal reason for this was the inducements offered by other shops, many of them paying full wages to apprentices who had worked two years and over in our works.

"Second, our term of apprenticeship was four years, and in order to satisfy these boys we found that it was necessary to change them about at least once in six months; in actual practice their services were little more than a kindergarten, because no sooner had they become sufficiently accurate and practical to turn out work on the machine which they were operating, and oftentimes before they were competent, they were dissatisfied if not transferred to another machine of the same type or one of different type.

"Third, we find in our business that it is much more practical to procure the services of intelligent laboring men from twenty to thirty-five years of age. They enter our services on a three-year contract. The first year we pay them practically what they would be able to earn at common labor, advancing them each year until their term is completed. These contracts call for continual service on one line of machines or work; that is, if a man is started in at lathe work he is advanced from one class of lathe work to another as rapidly as his ability will permit; the same with planer work, etc.

"With this system we are able to keep our machines in constant operation and usually we get practical reliable help. You will understand that in machine-tool building much greater accuracy is required than is the general practice in the ordinary lines of engineering work, and the average apprentice does not attain sufficient accuracy and experience, nor has he ability to turn out work in paying quantities, when his experience is limited to six months, when changed from one machine or one class of work to another; consequently, he cannot turn out work in paying quantities to permit him to have the use of a high-priced machine to get his experience on."

* * *

An important case in commercial law was recently decided in New York State which concerns the builders of machine tools, and especially machines of a multiplex nature. It was decided that under New York statutes, a customer, who, for example, bought a twelve-spindle drill, could not claim the difference in cost between it and a nine-spindle drill when he had received the nine-spindle drill and accepted it. The use of the nine-spindle drill was held by the court to be a virtual acceptance of the drill ordered, notwithstanding the fact that it had three spindles less than the twelve-spindle drill desired.

ELEMENTS OF MACHINE MANUFACTURE.*†

FRED J. MILLER.‡

Man has been described as a tool-using animal. He has used tools from the earliest times for obtaining food, making clothing and habitations, for defending himself, and for making war. It is only in comparatively recent times that he has made tools which are also machines, and which are therefore called machine tools, to distinguish them from the simpler tools which are used in the hands. In the present state of the arts and sciences these machine tools are the very corner stone and chief support of civilization. Without machinery our present mode of existence would be utterly impossible, and without machine tools we could have little, if any, machinery of any kind, agricultural, food preparing, textile, or transportation.

Machine tools are distinguished also from all other machinery because they possess, in a sense, the power of reproducing themselves. Machine tools are made by the use of machine tools. If we did not have any, the difficulty of producing the first machine tool would be enormous; but with a lathe, a milling machine and a planer to start with, the world's equipment of machine tools could be reproduced. In fact, it would be quite possible to do it with the king of machine tools, the lathe, alone. In view of these facts, machine tools, their design and construction, together with the manner of their use, constituting nearly all of what we call machine-shop practice, are well worthy of the most serious attention and study.

It might be inferred that from the first the most careful attention and study of the best equipped and best educated men would have been given to the subject of machine tool design—that the science of machine tool design would be among the things that had been most thoroughly worked out. This, however, is not the case. Generally speaking, the stresses imposed upon the various parts of a machine tool cannot be known to the designer of it. Different individual users, different shops in the same section, and different sections of the country have widely different views as to what constitutes a proper cut for a machine tool. Broadly speaking, there is to-day very considerable difference between New England and the Middle West as to what would be considered a proper cut for a lathe or planer.

Strength of Machine Tools.

Generally speaking, a designer can secure only unity of design in a machine tool, *i. e.*, he can make it approach the ideal of the wonderful one-horse chaise so that all the different parts will have substantially the same strength and power to resist wear in proportion to the load that will be placed upon them; but what that load will be, neither he nor anybody else can predict in most cases; that is determined by the user in his wisdom or his ignorance. For certain important work done in locomotive repairing, for instance, a certain railroad company uses something over three hours time of a man and an expensive machine tool. Another railroad company, using a similar lathe by the same maker, accomplishes the same work in 35 minutes. Shop practice is filled with these anomalies; and instead of there being fewer of them, as time passes on they have probably increased very much within the past ten or fifteen years, because shop practice has gone forward by leaps and bounds within that time, and, when rapid progress is being made, only a few keep pace with it; the rest drag out in a long

* Lecture presented before a class in mechanical engineering at the Columbia University, New York City.

† In accordance with the policy of the Department of Mechanical Engineering of Columbia University of closely associating the instruction with actual practice, engineers engaged in practical work are now giving instruction to the students in their own specialties The regular instructor also lectures in the same series. The courses in which this plan is followed extend through the third and fourth years. A course on Principles of Machine Manufacture comprising a detailed treatment of the economic performance of standard machine tools is conducted by Mr. Fred J. Miller, vice-president A. S. M. E.; Mr. Elmer Neff, of the Brown & Sharpe Mfg. Co.; Hugh Aikman, of the J. H. Williams Co.; Mr. D. B. Bullard, of the Bullard Machine Tool Co.; Mr. C. E. Coolidge, of the Niles-Bement Co., and Mr. George Jeppson and Mr. Charles H. Norton, both of the Norton Co. Courses will also be offered in elevating and conveying machinery, pumping machinery, air machinery, and refrigerating and icemaking machinery. In the fourth year, courses conducted with the assistance of outside experts will be offered in steam turbines, manufacturing plant design, works management, and water power machinery.

‡ Address: 280 Broadway, New York.

procession, the trailing end of which is out of reach and hearing, and knows not even that progress is being made.

One of the peculiarities of the branch of mechanical engineering which we are considering lies in the fact that, in designing and using machine tools the ultimate strength of a member is relatively of minor importance; because in this work, long before sufficient straining has occurred to constitute an approach to the breaking point, the deflection that takes place renders the tool useless for its purpose. Parts of machine tools that are turned, ground, scraped, or lapped true, receive this final refining treatment while under little or no stress. It is certain that every stress subsequently put upon them causes a deformation, and we must decide in each case whether or not the stresses to be imposed will produce deformation to an amount not allowable; remembering always that the allowable deformation in machine tools and machine shop fixtures is usually very small.

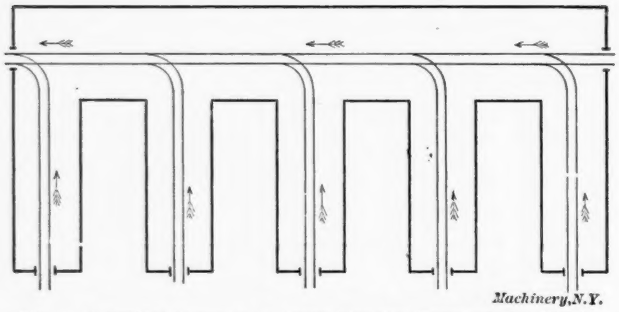


Fig. 1. A Typical Layout of a Large Machine Manufacturing Plant.

Suppose, for example, that we bolt a casting to be planed upon the platen of a planer. Suppose that by unskilled shimming, or for some other reason, the casting does not lie solidly upon the platen at all the clamping points. Then, when the clamping bolts are tightened, the casting and the planer platen are both deflected. If the casting is much weaker than the platen it will be deflected much more than the platen; if they are of equal rigidity they will be deformed equally; if the casting is stiffer than the platen, then the platen will be most deformed. The same thing applies to the face-plates of lathes, boring mills, etc., when the work is fastened to them, and failure to realize this fact accounts for much bad work. Besides, both castings and forgings change their shape by the removal of the outer portions; usually some slight change of form continues to take place for quite a long time after such removal of the outer portions; therefore lathe beds, plug-gages and other things which must be quite accurately finished, are usually machined to very near their finished dimensions and then laid aside for a time in order that this slow change in shape resulting from the disturbance of the balance between the various contending internal stresses may be completed before the final finishing.

Baking in an oven up to about 400 degrees F., and slowly cooling, shortens the operation very much. The heat sets the molecules, or the atoms, or whatever we choose to call them, in rapid motion, and, during such motion, the forces tending to deformation produce their proportionate effect upon the final resting place of the molecules. The piece thereafter changes comparatively little.

Thus we must not assume that machine tools and fixtures do not alter their shapes during constructive manipulation and use, for they certainly do to a greater or less extent. It is our business to see that they do not alter sufficiently to injuriously affect the work. The allowable deformation is, in the case of machine tools, probably less than in any other class of machinery, because accuracy of results is usually the first consideration in machine shop work.

Influence of Weight on Efficiency of Machine Tools.

Machine tools are somewhat peculiar in that mere weight seems sometimes to have an important influence upon their behavior, entirely independent of rigidity, or strength. When a machine tool has been designed to be plenty rigid enough—so that the deformation of its parts will be well within the allowable limits when subjected to legitimate stresses—one may still add more metal merely for weight, on what has been called the anvil principle. For example, a lathe taking a certain cut on work held between centers, chattered and acted badly. The small face-plate used merely to drive the work, through the medium of a dog, was removed and a large plate (as large as the lathe could swing) put upon the spindle nose in its place. Now the dog and the work were apparently driven precisely as before; neither the lathe spindle or any other portion of the lathe or work was more rigid than before; but the chattering ceased, and the cutting was steady. Whether the larger and heavier face-plate resisted torsional vibrations or lateral ones or both, I cannot say, but it seemed merely by its inertia or momentum to resist the rapid alternate accelerations and retardations which constitute vibrations. So far as I can see it added absolutely nothing except weight; but its effect was most strikingly beneficial.

This, however, does not mean that we should add chunks of pig-iron here and there for the purpose of getting sufficient weight; but it does mean that, sometimes, after patterns have been made heavy enough according to every rule and formula, they may be improved by being made still heavier, if they are for machine tools; as a prominent machine tool designer says: "In designing grinders, make them plenty heavy enough, and then as much heavier as the directors will allow."

Vibrations in machine tools seem to result in blows delivered upon the cutting edges of the tools, rapidly destroying them. In a large manufacturing establishment a great many twist drills were used which were 0.224 inch in diameter. This is an odd size and they could not be purchased at nearly as favorable prices as the standard sizes could be; and they were, therefore, made in the tool-room of the establishment in which they were used. At first a small, or No. 1 universal milling machine was employed in milling the helical grooves in these drills, but finally a larger machine by the same makers was installed for the general work of the tool-room. Occasionally both machines were employed in grooving the drills, and with the aid of special fixtures it was done rapidly.

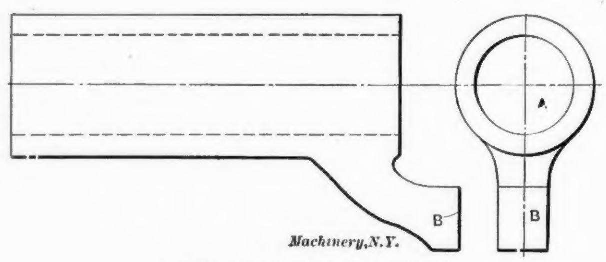


Fig. 2. The Work to be Machined.

The larger machine would have been pronounced entirely too heavy for the work, and it was used for these drills simply because it was more convenient to use both machines on the work at the same time. The cutters were made in large lots and were used indiscriminately on the two machines. The speeds were so arranged that the only practical speed on the larger machine was considerably higher than the one used on the smaller machine, but the cutters invariably held their edge and remained in service longer without grinding when used in the larger machine than when used in the smaller one. All conditions were favorable to an opposite result, except the greater weight of the larger machine. Its more massive knee and platen constituted a heavier anvil, which absorbed all vibrations. I became satisfied that if a machine were to be installed for use on that job continuously, the larger machine would have been the proper choice; although previous to that experience I would unhesitatingly have chosen the smaller as being ample for the work, as, I think, most others would have done, including the builders.

First Principles of Shop Construction.

One of the first things to be decided with regard to any shop designed for building a given machine is the general method to be pursued and the arrangement of the shop floor so as to have parts of machines progress between operations upon them in such a direction that, when finally ready for assembling, they will be near the place where they are wanted. There are two general ways of arranging for this.

In one, the castings coming from the foundry are delivered at one end of the shop, and at this end are the planers, chucking machines and boring and turning mills on which usually the first operations are performed upon castings. From here they progress from machine to machine for successive operations until, at the other end of the shop, they reach the stores or the assembling floor. About the same principle is applied in the case of forgings and it is quite common that castings and forgings enter the machine shop by the same door.

In the larger shops the alternative plan is often adopted of having a number of bays or shop floors arranged parallel to each other, either under the same roof, or separately, with open spaces between; these floor divisions all join, at one end, a floor running at right angles to them and usually devoted to assembling or erecting. Cars or trucks running on floor tracks, or overhead traveling cranes, convey materials through each of these bays, and the different classes of materials, entering at one end, progress toward the main bay; the progress of the work is analogous to the flow of water through various tributary streams until it finally reaches the larger river in which it again flows in one direction to its destination. Fig. 1 shows the direction of the movement of materials through the various sections of the shop.

In one bay there may be, for instance, the automatic and other screw machines; in another the smaller milling machines; in another the smaller lathes, planers, etc., while ordinarily there would be placed in the left-hand bay the heavier tools, floor plates, and portable tools required to deal with the heaviest castings. These when entering at the outer end of this bay, thus have the shortest possible distance to travel through the shop before reaching the general erecting floor at the left-hand end of the main bay, nearest the point of shipment.

Sometimes the main bay is higher than the others, to give head-room for the erection of large machinery, and there may be, along one side of the bay, a gallery devoted to such things as brass-working, automatic screw machines, gear cutting, etc.

The Cost Factor in Machine Manufacture.

One might suppose that, with the drawing or a sample of the machine before him, it would be possible for any one skilled in the art, by referring to data of the rates at which various operations can be performed to decide readily and almost infallibly, what methods to follow in carrying out any machine shop operation; but if one chooses a method based on the experience of a year ago, the chances are that he will deceive himself, and if he base his choice upon experience of five years ago, he will almost certainly be wrong. Besides, there are personal factors to be considered. It has been my experience that, in one first-class shop, there was a very firm belief that milling would not do at all for finishing lathe beds; that these must be planed, else time would be lost in scraping them true enough to pass inspection. In another shop all beds were milled and this was believed to be the best way of machining them. Both shops were in the front rank and both were doing the very best grade of work, of an approximately similar character, and in approximately equal quantities. It is evident that a very careful investigation would have to be made in order to decide which of these shops should be the model to follow in that matter; although it is certain that, if one could probe deep enough, one would surely find reasons for such variations in practice. One of these shops made neither planers nor millers and, presumably, had no interest in the one as against the other; while the other made both and, presumably, was as much in favor of the one as the other; so that this factor does not explain in this case such decided differences in practice.

Example of Decreased Cost Due to Interchangeable Manufacturing Methods.

In choosing a method of doing work, first, the quality of the work to be produced must be considered and then the quantity. I can perhaps best impress this by citing a case which has come within my own experience. A gray iron casting designed as the frame of a certain mechanism and shown partly in Fig. 2, was to be made. The first experimental machine had been made and tested, and four had been built precisely to the dimensions that were to be adhered to afterwards in manufacturing if, after the trial of these machines, it should be decided to take up their manufacture. The work to be done upon the castings was to bore accurately the hole *A* through the cylindrical body; face off the ends, true and square and to a definite length; and tool the surface *B* to a definite height above the squared end of the hub, true and square with it within a small limit of variation. The hole was cored in the casting, with about 3/16 inch to be removed in boring.

In the case of the first casting machined, it was held in the jaw chuck in an engine lathe, trued up by the usual process of chalk marking and adjusting, and then bored by a tool held in the tool-post in the usual way. At the same chucking the surface *B* was faced off and the adjacent end of the hub was then faced to give the right height for *B*; all this involved, of course, careful work by a skilled man. The piece was then reversed in the chuck, and by means of an indicator

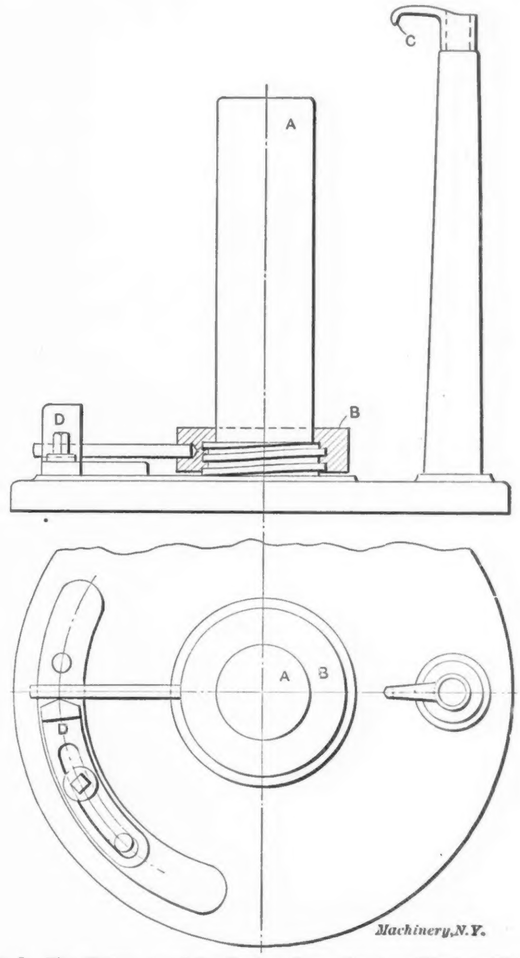


Fig. 3. The Fixture used for Facing Operations on Work in Fig. 2.

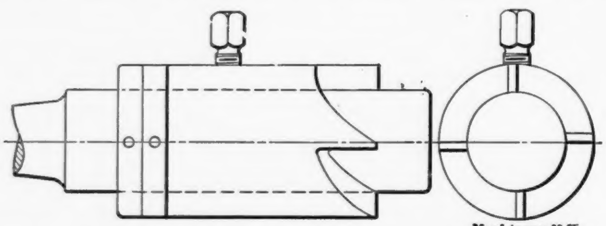
the bore was carefully trued up and the other end of the hub faced to give the piece proper length. For these operations it would have been put upon an arbor if the hole had been of any standard size for which an arbor had been on hand, but this was not the case. The cost of this machining was about $2.50.

Later, ten more castings were required, and for these it was thought worth while to make a flat chucking drill to precede the lathe boring tool and an arbor on which to drive them while facing the ends and the surface *B*. This facilitated matters somewhat, and reduced the cost of machining to about $1.50 each.

It was then decided to manufacture the machine of which this formed a part, and fifty per day were to be made. The lathe was now entirely abandoned for this work, and two ordinary drill presses of good quality and with automatic feed were placed side by side and close together. A fixture was made for one of them which simply held the casting vertical, the hub resting against set-screws fitted to the frame of the fixture, with check nuts to hold them when adjusted.

A clamp held the piece against these set-screws and it was not necessary to tighten this very hard, because the lug *B* was allowed to come against a projection in the fixture and prevent rotation of the work. A hardened and ground steel bushing in the top of the fixture guided the boring tool which was what is by some called a butt-mill and by others a three-four-, or six-fluted twist drill. It was simply a solid cylinder with a taper shank to fit the drill spindle, and having cut upon its cylindrical surface four helical grooves of such a shape that the ends of these grooves formed radial cutting lips. They were made radial, *i. e.*, they were ground to lie in or nearly in a radial plane because cored holes in castings do not, by any means, come true, and, where the core is considerably out of center, any cutting lip which is ground at an angle similar to that of an ordinary twist drill, will be crowded over by the heavier cut on one side; whereas, if the cutting lips are square, there will be no tendency to crowd off and much better results will be obtained.

The workman (not a skilled mechanic but a specially trained man) started boring and threw in the automatic feed. While the boring was thus going on, he reamed, with a hand



Machinery,N.Y.

Fig. 4. The Facing Tool Employed.

reamer, the piece which had been previously bored, removing about 0.003 inch. He then placed this reamed piece upon the stud in the fixture shown in Fig. 3. This fixture was mounted upon the table of the second drill press with the stud *A* directly under the spindle. In the spindle was the facing tool shown in Fig. 4.

The work was first placed upon the stud so that the upper end, or that having the arm on it, was uppermost and the collar *B* was rotated until, by means of its internal square thread, it lowered the work upon the stud until the, as yet uncut face of *B*, Fig. 2, was at the height of the swinging gage *C*, Fig. 3. This was so made that, when the piece was adjusted to it, as described, enough metal would be left on the surface *B*, Fig. 2, to give a fair milling cut. The facing tool, Fig. 4, was then brought down and the facing continued until the end of the shank and the top of the stud *A*, Fig. 3, came together and thus stopped the cutting. The work was then reversed, *i. e.*, placed upon the stud with the opposite end uppermost, when the collar *B*, Fig. 3, was raised by rotating as before until the pin by which it was rotated came in contact with the stop *D*. The facing cutter could also be adjusted vertically upon the shank and was held in place by the threaded collars above it. All adjustments of the fixture and the grinding of the facing cutter were done by a skilled man, so that the operator had nothing to do but handle it as directed. By means of these tools, all this work was done while the boring was going on in the first drill press, and the labor cost was reduced to that necessary for the boring only. The face *B*, Fig. 2, was afterwards milled off while the piece was held in a fixture which permitted the use of a face mill.

By the plan described, the cost was reduced to about 6 cents per piece, as compared with the $2.50 and $1.50, which precisely the same work had cost by the methods previously described. Now, considered by itself, no one of these methods was necessarily any better than another. Each was adopted because believed to be the best for the conditions presented at the time. The first method, or one very similar to it, would still be the best one to follow if only one piece were to be made and if there were no assurance that there ever would be another like it.

As a first consideration the method followed in each case had to be such as to produce the results aimed at in accuracy, etc. After that it had to be adapted also to the number of pieces which were to be made, or the rate at which they were to be produced; this case has been described in detail to show that the best method of doing identically the same work usually depends very much on the quantity to be done, or the rate at which it is to be done. But it is not always possible to know how many pieces are to be made alike, and one of the most difficult problems connected with manufacturing is to decide wisely whether or not to make fixtures at a given time. A rule that is sometimes used is to make jigs and fixtures only when it is believed that their cost will be saved in one year. Some establishments charge off 20 per cent of the original cost of all fixtures at each yearly inventory, thus distributing their cost over a period of five years. One very prominent machinery building concern makes good jigs and fixtures for every machine it builds; this is done mainly because interchangeability and ability to supply parts at any time that will fit and work without question is a part of every sale or lease contract, and jigs and fixtures afford the only practical means known to them of certainly securing that object.

Rapid Development of New Tools and Methods.

Scarcely anything is as yet finally settled with regard to the details of shop practice. If to-day we are to consider the production of a new machine, the decision with respect to many things connected with its manufacture would vary between different experts; and, any decision which is reached at the present time would almost certainly differ from one that would have been reached a year ago, as well as be subject to revision a year hence.

High speed steel has exerted an important influence, enabling surplus metal to be removed from castings and forgings much more rapidly than was possible a few years ago; but this has not in the least shortened or reduced the cost of many of the most expensive operations which go into the production of machinery, *i. e.*, the careful laying out of the work, the careful measuring and gaging necessary to secure the required accuracy; the grinding, lapping, scraping, finishing and assembling. It has reduced the cost of turning, boring, drilling, milling, and planing, and, in some lines of work, these operations constitute the principal elements of cost; but in other lines they are relatively less important, and the faster rate at which these operations can now be done has affected the cost of production of such lines of machinery comparatively little.

Milling is a process which, within recent years, has undergone such changes that one who should have to decide as between milling and planing or upon the type of miller to install or the number of them needed for a certain production, would need to know the very latest attainments in that line. At first milling cutters were almost what might be called disk-shaped rotary files and were, in fact, used as substitutes for files, especially in producing forms which it was necessary to reproduce in considerable numbers with considerable accuracy—gear teeth for instance. The rate at which work was done was considered very fast, because it was so much faster than the methods which it displaced; but such a rate of doing milling would now be considered absurdly slow. Probably few milling machines used in those early days could remove more than a pound of metal per hour.

At the latest general meeting of the American Society of Mechanical Engineers a cutter was described that converts into chips and removes nearly 13.5 pounds of cast iron per minute. If capacity to remove metal were the only controlling factor, such figures would make it pretty easy to decide in most cases. But very often the amount of metal to be removed and the character of the pieces from which it is to be removed do not permit of milling at a rate anywhere near the figures given, and other factors have much to do with the choice of machines and methods.

The art of grinding has also progressed very rapidly within recent years. Grinding machines, at first used in machine shops almost exclusively for shaping or perfecting the forms of hardened steel pieces, are now quite generally used for finishing, to size and truth, spindles, piston-rods, automobile engine crank-shafts and numerous other things which are first turned roughly and considerably above the finished size; a very high finish is produced at less cost than that at which an inferior one could have been produced a few years ago.

Power for Machine Tools.

In nothing, perhaps, is the difficulty of establishing definite rules for machine shop practice more clearly shown than when we investigate the matter of the power required to drive machine tools. An old rule was to provide one horse-power for each ten men employed in a machine shop, including bench hands and all others, whether using power or not; and that rule fitted very well with former machine-shop practice. For any of the most modern machine shops, however, such an allowance would be absurdly inadequate.

As regards the practice of to-day, for example, the Westinghouse Electric and Mfg. Co., which has had a very extensive experience in equipping machine tools with electric motors, says that the conditions under which machine tools operate are so varied that it is impossible to represent even by empiric formulas the exact horse-power which should be used in all cases. They give some formulas, however, based on average practice, and assuming that ordinary carbon steel tools are used, the assumed cutting speed being 20 feet per minute. Under abnormal conditions of either machine or work the formulas will give very much smaller horse-powers than those which should be applied to the various machines.

For engine lathes: $H.P. = 0.15S - 1$ in which S is the swing of the lathe in inches. This would give, for a 10-inch swing lathe, a motor of 0.5 H.P. and for a 20-inch swing lathe 2 H.P. It may be remarked that, although the cutting speed is the same, the 20-inch lathe will have a motor four times as powerful as the 10-inch lathe, and that, if the cut taken were of the same character, the power required would be the same for both. The only way of accounting for the difference is in the fact that heavier chips are taken in the 20-inch lathes and also that more power is required to drive the lathe itself.

For lathes doing specially heavy work, such as forge lathes, the formula given is: $H.P. = 0.234S - 2$ which for a 20-inch lathe of this description would give 2.68 H.P. This is less increase of power as compared with the ordinary 20-inch lathe than might have been looked for. It will be found, however, that, as the sizes of the lathes increase, the power provided by this formula increases in a greater ratio than by the first. Thus, comparing 30-inch lathes, for example, we get 3.5 H.P. and 5 H.P., respectively, and for 40-inch lathes, 5 H.P. and 7.4 H.P., respectively.

For boring and turning mills the same authority gives: $H.P. = 0.25S - 4$ in which S = the swing in inches. This, for a 6-foot mill, gives 14 H.P. The formula for a lathe of the same swing would give us only 9 H.P.; but that formula is based upon the use of only one cutting tool; whereas boring and turning mills ordinarily use two and often more.

For drill presses the formula is: $H.P. = 0.06S$, where $S =$ the swing of the drill press in inches; or for a heavy radial drill press: $H.P. = 0.1S$.

For planers of ordinary proportion between length and width the formula is: $H.P. = 3W$, where W = width between the housings in feet. For heavy planers for forge work: $H.P. = 4.92W$. These formulas provide for two tools cutting simultaneously; for a return speed of 3 to 1, and also for the overload at the moment of reversal. The increase in power required at the moment of reversal is considerable, and the motor must be of sufficient capacity to avoid that degree of momentary overload which, if the planer were to be used always at full stroke, might well be borne, but which becomes too much for the motor when the stroke is so shortened as to keep the planer for a very large proportion of the time in the act of reversing, and thus gives the motor practically a continuous overload.

The formula given for slab milling machines is: $H.P. = 0.3W$, in which $W =$ distance between the housings in inches. This is for carbon steel cutters running at 20 feet per minute cutting speed; for a machine having 42 inches between housings the formula gives 12.6 H.P.

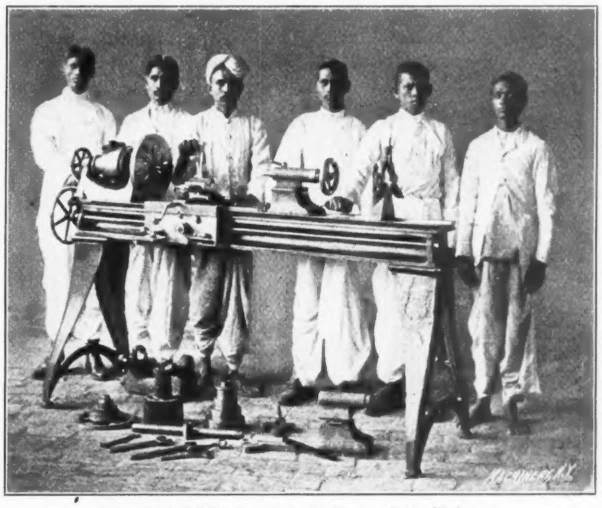
In a paper by Messrs. Wilfred Lewis and Wm. H. Taylor, presented at the annual meeting of the American Society of Mechanical Engineers December, 1908, some experiments with a milling cutter provided with helical, inserted blades of high-speed steel were described, with which cutting was done in a miller 42 inches between housings, and milling steel at a cutting rate of 88 feet per minute. As the power required to drive a milling cutter is proportional to the speed of the cutter, our formula would give 55.4 H.P.; but the power actually used in the experiment was 92.7 H.P., or, nearly 70 per cent more than the formula gives. This is a striking example of the fact, clearly recognized by the Westinghouse Company, that "the above formulas may be useful in approximating the horse-power required under given conditions, but it has been found that it is impossible to derive any formula which will take account of all the operative conditions and the results given by the formulas must be invariably tempered by judgment, based upon the character of the work, personnel and numerous other factors."

Much the same thing applies throughout the field of productive engineering. This, however, is no reason for becoming discouraged at the prospect of ever mastering it, for it is for this very reason that it is perhaps the field which, above all others, gives the widest scope for individuality and noteworthy achievement.

* * *

THE FIRST LATHE MADE IN INDIA.

The accompanying illustration shows a machine of considerable general interest because of its makers, and the fact that it is the first lathe constructed in India. It is a copy of a Barnes No. 13 engine lathe manufactured by the W. F. & John Barnes Co., Rockford, Ill., and was constructed



The First Lathe made in India, and its Makers.

almost entirely by native Indian boys in the Methodist Episcopal Industrial School at Nadiad, India. Mr. H. F. Bishop, who is at the head of the school, says that very little machinery is built in India, and that what is made is mostly confined to railway work, cotton mill machinery and fittings, and structural steel fabrication. The Mission Industrial School is endeavoring to start manufacturing along the lines of small machinery, tools, etc., which will give employment to the natives and lift the industries of the country out of the primitive state in which they generally exist. Mr. Bishop writes that the lathe built by these Indian boys, who but a few years ago were ignorant famine waifs, works as satisfactorily as the original lathe. Of course the castings are somewhat rough and the illustration shows it because no filling or painting was done to improve the surfaces.

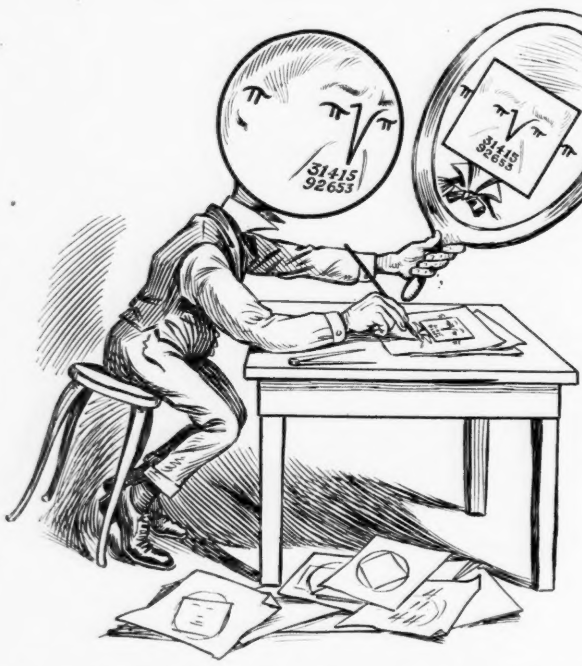
* * *

Some of the native Australian woods have a very high tensile strength. The *Practical Engineer* states that the blue gum of Tasmania has an ultimate strength of 29,800 pounds per square inch, and weight for weight has 2.3 times the strength of nickel steel. The modulus of elasticity is 3,500,000. The swamp gum, red gum and salmon gum wood, also Australian native woods, have a tensile strength of about 20,000 pounds per square inch. Weight for weight, the swamp gum wood has double the strength of high-grade structural steel. While the tensile strength of these woods is high, the shearing strength is low as compared with steel as it does not exceed 2,000 pounds per square inch for any of the woods mentioned.

THE SQUARING OF THE CIRCLE.

ANTONIO LLANO.*

The squaring of the circle is a problem that everybody has heard of, but of which many persons have but a very vague idea. It has engaged the attention of mathematicians from the dawn of civilization to our own time, and been the source of many great discoveries; nor has its fascinating power failed to engage and wreck the scanty intellects of uncultured men that, having been destined by nature to dig the soil or guide the tilling plow, have lost what little reason they had in vain endeavors to solve a problem that some of them could



"Nor has its fascinating power failed to engage and wreck the scanty intellects of uncultured men."

not even state. The following brief exposition of the true nature of this problem, as well as of the simpler problems on which its solution depends, may be of interest to those that are not familiar with the subject; while the approximate graphic solutions given may prove useful to the draftsman.

The simplest way of stating the problem is this: *Given a circle, to construct a square that shall have the same area as the circle.*

It should be noted that the required square is to be *constructed;* and this means that the side of the square is to be determined graphically with no other instruments than a straightedge or ruler and a pair of compasses. It is not necessarily required that the length of the side of the square should be computed; what is required is that a line should be drawn, whether its length can be calculated or not, that shall fulfil the conditions of the problem. An illustration will make clear the difference between solving a problem by computation and solving it by geometrical construction. The two methods are called, respectively, the *analytic* and the *graphic* method.

Suppose that a rectangle R, Fig. 1, is given, and that it is required to find another rectangle that shall have the same area but a different base c.

In the analytic method, the lengths of the base b and altitude h of the rectangle R, and of the base c of the required rectangle, are either given or determined by actual measurement. Suppose $b = 12$, $h = 3$, and $c = 9$, and denote by x the altitude of the required rectangle. Then, since the two rectangles are to have the same area, we must have

$$9 \times x = 12 \times 3 = 36,$$

whence $x = 36 \div 9 = 4$.

In the graphic method, it is immaterial what the lengths of b, h and c are, provided these lines are given on paper; that is, provided they are already drawn. Draw AB, Fig. 2, equal to b. From A, lay off $AC = c$. From C, draw $CH = h$ in any direction other than the direction of AB. Draw AH, and produce it. From B, draw BX parallel to CH, intersecting AH produced in X. Then BX is the altitude of the required rectangle. For the similar triangles ACH and ABX give

$$AC : CH = AB : BX;$$

that is,

$$c : h = b : BX,$$

whence $c \times BX = b \times h$, as required.

When the object of a geometrical probem is to draw a line satisfying certain conditions, the line can always be drawn if its exact length can be computed; that is, a geometric construction can always be accomplished if an *exact* analytic solution can be found. Thus, in the preceding example, the rectangle can be constructed after its altitude x has been calculated. The converse proposition, however, is not true: a problem may have an exact graphic solution, and yet not have an exact analytic solution. Suppose, for example, that it is required to find the hypotenuse of a right-angled triangle whose sides are 5 and 3. We may draw a right angle, and lay off from its vertex, to any convenient scale, the lengths 3 and 5 of the sides; the line joining their extremities is the required hypotenuse. Yet, we cannot exactly determine this hypotenuse by computation, since its length is $\sqrt{9+25}$, or $\sqrt{34}$; and, although we can express $\sqrt{34}$ to any desired degree of approximation, we cannot determine its exact value.

The following additional illustration of the principle just explained has a direct bearing on the problem of squaring the circle. Let it be required to determine the side of a square having the same area as a triangle whose base and altitude are b and h, respectively. If the side of the square is denoted by x, the analytic statement of the problem is

$$x^2 = bh \div 2$$

and the analytic solution is

$$x = \sqrt{bh \div 2}$$

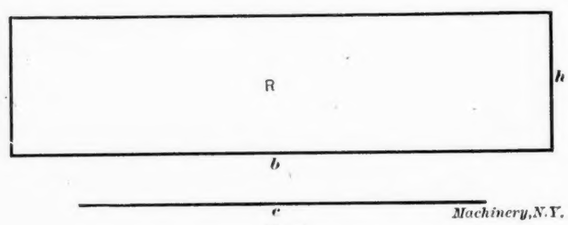


Fig. 1.

If $\frac{1}{2}bh$ is a perfect square, the value of x can be determined exactly, and the square readily constructed. Thus, if $b = 24$ and $h = 3$, $bh \div 2 = 36$, and $x = \sqrt{36} = 6$. If $bh \div 2$ is not a perfect square, there is no exact analytic solution. The exact geometric solution, however, is always possible, and is accomplished thus:

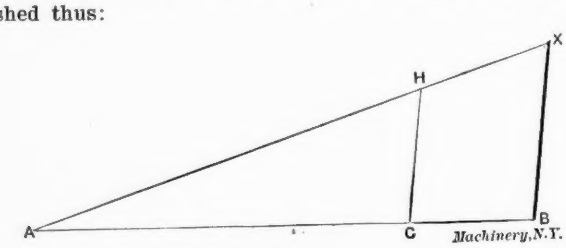


Fig. 2.

On an indefinite line AP, Fig. 3, lay off $AB = b \div 2$, and $BH = h$. Bisect AH at O, and, with center O and radius OA, describe a semicircle AQH. At B, erect a perpendicular to AH, intersecting the semicircle in X. Then BX is the side x of the required square. This follows from the fact that, the angles of the triangle ABX being equal to those of the triangle EBH, the two triangles are similar, and, therefore,

$$AB : BE = BX : BH, \text{ or } AB : BX = BX : BH,$$

whence

$$BX^2 = AB \times BH = (b \div 2) \times h = bh \div 2$$

Here, then, we have another case in which the graphic solution of the problem is always possible, whether the analytic solution is possible or not.

We may now return to the squaring of the circle; or, as mathematicians call it, the *quadrature* of the circle. If the area of a circle of given diameter could be exactly calculated,

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the construction of the equivalent square would offer no difficulty. Suppose, for example, that the exact area of a circle is 15.75 square inches. This area may be expressed as the area of a triangle having a base of (2×15.75) inches and an altitude of 1 inch, and the equivalent square can be constructed in the manner already explained.

It is, then, natural to try first to find an expression, or formula, for the area of the circle in terms of the diameter or of the radius. The investigation leads to the conclusion that the area of a circle is equal to the area of a triangle whose base is the length of the circumference and whose altitude is the radius of the circle; so that, if the length of

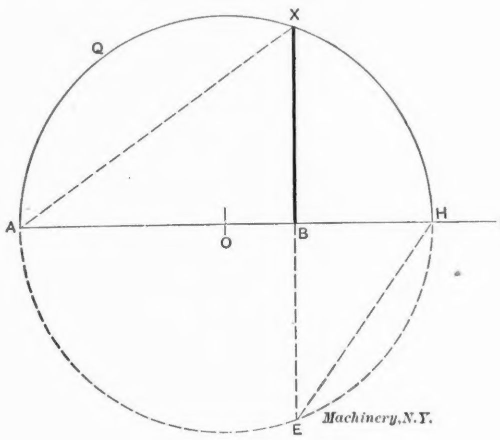

Fig. 3.

the circumference can be either computed or constructed, the area of the circle and the side of the equivalent square can be readily determined.

Algebraically, the relation between the area A, the radius R and the circumference C is thus expressed:

$$A = R\,C \div 2$$

Since all circles have the same form, any two circles of different diameters may be regarded as being the same circle drawn to two different scales; and so their circumferences must be proportional to their diameters or to their radii. If, for instance, the diameter of a circle is three times the diameter of another circle, the circumference of the former circle must be three times the circumference of the latter. Let R, D and C be, respectively, the radius, diameter and circumference of a circle, and R_1, D_1, C_1 the radius, diameter and circumference of another circle. Then, the principle stated above may be expressed algebraically as follows:

$$\frac{C}{C_1} = \frac{R}{R_1}, \text{ or } \frac{C}{C_1} = \frac{D}{D_1}$$

From the second of these two equations is derived the important relation

$$\frac{C}{D} = \frac{C_1}{D_1}$$

We thus see that the ratio of a circumference to its diameter is the same as the ratio of any other circumference to its diameter; that is to say, that the number obtained by dividing the length of any circumference by the length of its diameter is *constant*, or fixed, or always the same. This fixed number is usually denoted by the Greek letter π (called *pi*). From the equation $\frac{C}{D} = \pi$ follows

$$C = \pi D = 2\,\pi R.$$

If we knew the exact value of π, the circumference C, and therefore the area A, and the side of the equivalent square, could be determined, as already explained. The squaring of the circle, then, finally reduces to the determination of the number π. The French geometer Legendre proved, over 100 years ago, that π is an incommensurable quantity; that is, a quantity that, like $\sqrt{2}$, $\sqrt[3]{12}$, cannot be expressed exactly by any number, either integral or fractional. This disposed of the analytical solution of the problem, showing that it was impossible. The graphic solution, however, still remained a possibility, until the German mathematician Lindeman proved, in 1882, that this solution, also, is impossible.

But, although no exact solution of the problem is possible, approximate solutions, both analytical and graphical, have been found that meet all the requirements of practical computation and drafting. Various methods and formulas have been devised by which the value of π can be obtained to any required degree of approximation, and some astoundingly patient calculators have computed this mysterious number to more than seven hundred decimal places. For very accurate work, the approximate value 3.1415927 is used; but, for nearly all practical purposes, 3.1416 is considered close enough. One-fourth of the latter value, or .7854, serves to calculate the area of a circle in terms of the diameter, according to the formula

$$A = \frac{R}{2} \times C = \frac{D}{4} \times \pi D = \frac{\pi D^2}{4}.$$

The value of π to twenty decimals is

3.14159265358979323846.

This value, as well as closer values, is obtained by means of series. Elementary geometry, however, affords some methods that, although exceedingly laborious, were for a long time the only ones used for the determination of π. The simplest method consists in computing the perimeters of the inscribed and circumscribed square in a circle of diameter 1; from these, the perimeters of the inscribed and circumscribed polygons of 8 sides; from these, the perimeters of the polygons of 16 sides, and so on. Since the length of the circumference lies between any two corresponding perimeters, the figures that these two perimeters have in common are figures

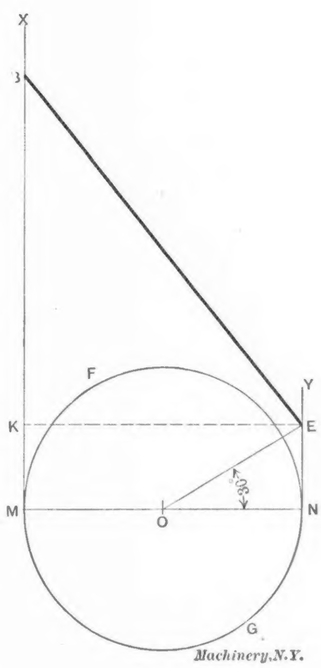

Fig. 4.

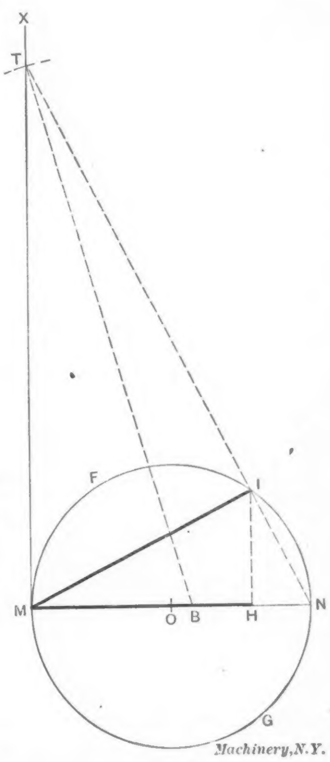

Fig. 5.

of the number expressing the approximate length of the circumference, and, therefore, the approximate value of π, for in this case $C = \pi \times 1 = \pi$. It is found by this method that the perimeters of the inscribed and circumscribed polygons of 8,192 sides are, respectively, 3.1415926 and 3.1415928, nearly; whence it follows that the value of π, to six decimals, is 3.141593.

The value $\frac{22}{7}$, or 3.143, is convenient for rough calculations and estimates. A much closer value is that determined by Peter Metius in the sixteenth century: namely, $\frac{355}{113} =$ 3.1415929. The common fraction expressing this value is often used for slide-rule computations; it can be easily remem-

bered and written by applying the following rule: Write twice each of the first three odd numbers, thus: 113355; divide the resulting group of figures into two groups of three figures each: the first group, 113, is the denominator of the fraction; the second group, 355, is the numerator. Since π is greater than 1, it is easy to tell which of the two groups is the numerator, and which is the denominator.

Of the approximate graphic solutions, one of the simplest consists in adding to 3 times the diameter one-fifth the side of the square inscribed in the circle; the result is the approximate length of the circumference. This method is equivalent to taking $\pi = 3.14142$.

A construction that gives a closer approximation than the preceding is as follows: Let FG, Fig. 4, be the given circle, O its center, and MN any diameter. Draw the tangents MX and NY. On MX, lay off MB equal to 3 times the radius. Draw OE making an angle of 30 degrees with ON (which can be very readily done with a drawing triangle). The line BE will then be, approximately, equal to one-half the circumference. This method is equivalent to taking π equal to 3.14153, which differs but little from the usual value 3.1416.

The following construction is due to the French geometer H. Sonnet: Draw the diameter MN and the tangent MX, Fig. 5. From the center O, lay off OB equal to one-sixth the radius; from B, with a radius equal to twice the diameter, describe an arc cutting MX in T. Draw TN, intersecting the circumference in I. Then, the chord MI is, approximately, equal to the side of the equivalent square. Draw IH perpendicular to MN. Then, MH is, approximately, equal to the length of a quadrant, or one-quarter of the circumference. This method is equivalent to taking $\pi = 3.14158$—a very close approximation.

In practice, when the numerical value of the diameter, expressed in units of length, is known, the simplest way to lay off the length of the circumference on a straight line is to multiply the diameter by 3.1416, or, if a slide-rule is used, by $\frac{355}{113}$, and lay off the result to scale. When, however, a circle is simply given on paper (on a drawing), its exact diameter not being known, the graphic solutions are usually more convenient.

* * *

FORMULAS AND TABLES FOR HORSE-POWER OF GASOLINE ENGINES.*

MORRIS A. HALL.†

The horse-power of a gasoline engine can, of course, be figured easily enough from the well-known formula

$$\frac{PLAN}{2 \times 33,000}$$

in which

P = the mean effective pressure,
L = the stroke in feet,
A = the area of the piston or cylinder bore in square inches,
N = the number of revolutions per minute.

In order, however, to save calculations a table can be prepared, giving at a glance the horse-power of gasoline engines, when the bore and the stroke are known. Such a table is presented in the accompanying Supplement in Table I. This table shows the indicated horse-power or ideal power. To obtain the actual horse-power from the indicated horse-power given in the table, the figures stated must be multiplied by a factor based on the mechanical efficiency of the mechanism, which may vary from 94 to 70 per cent, and in some cases even less. As a fair average, however, 80 per cent may be used in the calculations. In the table presented in the Supplement the bore is given in the left-hand vertical column, while the stroke is given in a horizontal line at the top; beginning with a stroke which is equal to the bore, which is found in the column headed bore + zero, the stroke increases in each successive column by ¼ inch up to the final column, which is 2 inches longer than the diameter of the bore. Thus the powers given are for engines varying from 2-inch diameter by 2-inch stroke, up to 6½-inch diameter by 7-inch stroke. The figures given are, of course, for a single cylinder, and for multi-cylinder engines all that is required is to multiply by the number of cylinders. In figuring the table, the formula stated at the beginning of this article was used, the mean effective pressure being taken as 90 pounds per square inch, and the number of revolutions as 1,000 per minute. Ninety pounds mean effective pressure corresponds to a compression pressure of 68½ pounds. This may be verified by using Grover's well-known formula:

$$P = 2C - 0.01C^2,$$

where C is the compression.

This compression of 68½ pounds is taken as an average figure, but the compression may in reality vary all the way from 60 to 100 pounds, and racing automobiles have been built using a compression of 120 pounds.

As cars using 60 pounds compression, we may mention the Franklin and Covert cars; the Thomas and Moline cars use 65 pounds, while the Columbia cars use 100, and the Acme, 102. For these cases, the power corresponding may be found from the table by multiplying the figures there given by the following factors:

For 60	pounds	compression,	multiply	by 0.933
" 70	"	"	"	" 1.011
" 80	"	"	"	" 1.066
" 90	"	"	"	" 1.100
" 100	"	"	"	" 1.111

As an example taken at random, illustrating the use of the table, let us find the power for a 5½-inch bore, 6-inch stroke, 4-cylinder engine. In the line of 5½-inch bore and in the column headed bore + ½ inch, we find the value 16.2, which, multiplied by 4, gives 64.8, as the indicated horse-power. Assuming a mechanical efficiency of 80 per cent, we get 51.8 H. P. as the actual horse-power. In Table II is given the direct or actual horse-power of gasoline engines, as figured from the empirical formula

$$\frac{D^2}{2.5} = \text{horse-power}$$

which was recently adopted by the Association of Licensed Automobile Manufacturers. This formula is based on a piston speed of 1,000 feet per minute, which gives 2,000 R. P. M. for a 3-inch stroke, 1,500 R. P. M. for a 4-inch stroke, 1,200 R. P. M. for a 5-inch stroke, and 1,000 R. P. M. for a 6-inch stroke. This table would then compare with Table I only on the basis of 1,000 R. P. M., which would give a uniform stroke of 6 inches for all engines regardless of diameter. As an example, take the same engine as above, 5½ inch diameter by 6-inch stroke, having 4 cylinders. In the table we find the horse-power given as 12.10. This, multiplied by 4 gives us 48.4, which is reasonably near the figure 51.8 for the horsepower, previously found, to indicate that the empirical formula given above is approximately correct.

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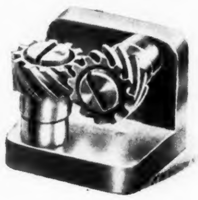
* * *

Consul-General Frank H. Mason writes from Paris that some of the noticeable features at this year's exposition of automobiles in Paris was the evidence of the low-priced car, and the general attempt to reduce the price of standard automobiles, without reducing their comfort or usefulness. This reduction in price has been partly achieved by elminating unessential features, and also by improved construction tending towards simplification. Larger and more comfortable bodies have been placed on moderate sized frames; the cylinders are cast uniformly in one piece, and the motor is placed further forward on the chassis, with the radiator behind it. The gear boxes are shorter and smaller, and the cardan shaft and live axle drive are almost universally used on vehicles below 25 horse-power. Forced feed-lubrication is used on the high grade types. The high tension magneto is replacing the low tension type. Self-starting devices are common, even on medium priced cars, and the honey-combed radiators are losing ground.

* * *

The very best formal training for a young man is that of an engineer, no matter what pursuit he may follow. It establishes the true value of efficiency, the habit of orderly thinking.

CUTTING HELICAL GEARS ON THE BROWN & SHARPE AUTOMATIC SCREW MACHINE.



The ribbon spools of a certain typewriter are rotated by a system of shafts and gearing, which includes a pair of small spiral gears—or helical gears, rather, to be exact. These, until recently, were cut on small hand-operated gear-cutting machines of special design, which performed the operation in the same way that helical gears are cut in a milling machine; that is to say, the blank was fed forward and rotated at the same time under a revolving formed cutter. It was then returned to the starting position again, indexed and fed forward for a second cut—and so on until all the teeth were formed. Having had some previous experience in cutting triple worms for gas meters in the automatic screw machine, the Brown & Sharpe Mfg. Co. undertook to cut these helical gears in the same way. The tools and operations employed for this work are herewith illustrated and described. The effectiveness, rapidity, and comparative simplicity of the mechanism employed, will at once appeal to the mechanical mind; and the job, as a whole, is a first-rate piece of evidence of the versatility of the automatic screw machine.

Helical Gear Generating Tool for the Screw Machine.

The machine is shown rigged up for producing helical gears in Fig. 1. Figs. 2 and 3 show front and rear views of the tooth-generating tool, and Fig. 4 shows details of its construction. The principle of its operation will best be understood from the latter engraving.

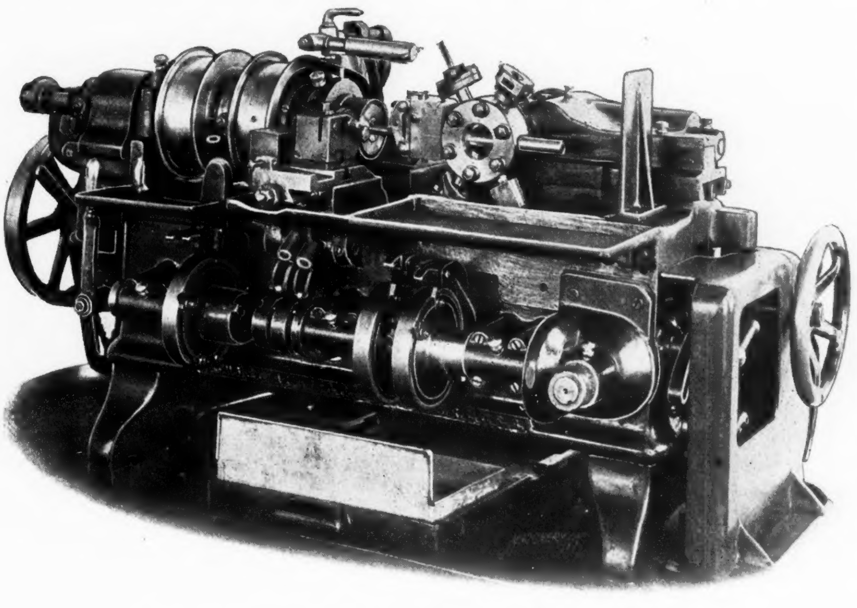


Fig. 1. An Automatic Screw Machine, arranged for Gear Cutting.

When this tool comes into action, the blank has been formed in the machine to the condition shown at *D* in Fig. 5. The hole has been drilled and reamed and the outside diameter formed to the required dimensions. When the tool is brought up to the work the three-cornered driving center *G* enters the drilled hole, and is thereby caused to revolve with the blank. As it is screwed firmly into the long driving gear *H*, this latter is also set in motion in unison with the spindle of the machine. Gear *H* has helical teeth cut on it engaging mating teeth in helical gear *J*, which is mounted on a short horizontal shaft having spur gear *K* keyed to it at the rear end. This gear, through a large idler *L*, drives gear *M*, which is keyed to the cutter spindle *S*. Cutter *N* mounted on the spindle has the form of a helical gear properly cut to mesh with the gear to be formed. It is made of hardened tool steel and is ground on one face, which face is set as shown in the end view, so that it is in the plane of the axis of the work. By means of the train of gearing just described, it will be seen that cutter *N* may be caused to revolve in unison with the work as though it were in mesh with the latter after the teeth have been cut.

Driving center *G* and the front bearing of gear *H* are supported in a sliding bushing *O* seated in the body *P* of the tool. A plunger *Q* in the shank of the tool is pressed by a long and stiff spring against the end of the bearing of *H*. This serves to keep *G* pressed into the hole in the work. As the tool advances over the work, *G* and *H* are forced back with relation to the holder, remaining stationary so far as endwise movement is concerned with relation to the work. The thrust between *Q* and the end of *H* is taken by a hardened ball pivot bearing as shown, so that the friction is inappreciable. The extended lip on the bushing *O* is simply for the purpose of providing the long keyway shown, which engages a pin in the body *P* to prevent *O* from turning. When the tool is not in contact with the work, screw *R* limits the outward movement of *G*, *H*, and *O* produced by spring plunger *Q*.

The Operation of Cutting the Teeth.

Consider now that we have a gear blank in the machine with the teeth all cut but not yet severed from the bar, and suppose the cutter *N* to be meshed with it as shown at *D* in Fig. 5. Suppose further that the spindle of the machine has been stopped. If now the turret slide be moved forward or back from the position shown, so that tool *P* is pushing forward or back over the work, center *G* and gear *H* remain stationary with reference to the work, but move back and forth with relation to the tool-holder. This axial movement of gear *H* will evidently rotate helical gear *J*, which, through the train of spur gears *K*, *L* and *M* will in turn rotate the cutter *N*. The ratio of this train of gearing is such that the rotary movement given to *N* by the longitudinal movement of the tool-holder in either direction keeps it exactly in step with the teeth of the work. Thus the movement of the turret slide rolls the cutter on the work just as if the latter were mounted perfectly free on its axis and were rolled by the teeth of the work itself, instead of through the train of gearing described.

Consider further, with the cutter and work set in the relation shown in Fig. 5, that the turret slide of the machine is fixed in position, but that the spindle and the work is rotated. The rotation of the gear revolves the three-cornered driving center *G*, which, in turn, transmits its motion to gear *H*, and thence to gears *J*, *K*, *L*, *M*, and cutter *N*. The ratio of this train of gearing is again such that the rotary movement thus given the cutter is in the proper ratio to keep the latter in step with the teeth cut in the work, so that the work and cutter revolve together as if they were a pair of helical gears driving each other, with no connection through the train of gearing.

It has thus been shown that the cutter will be kept in step with the work if the tool is moved axially back and forth over the work while the latter is stationary. It has also been shown that the cutter will keep in mesh with the work, while the latter is revolving and the turret slide and the tool are stationary. Since the cutter and work are kept in step under these two conditions separately, they are still in step when the two movements are combined. This tool and its arrangement of gearing can thus be moved back and forth over the revolving work without throwing the teeth in the cutter and the teeth in the work out of step with each other. This always supposes, of course, that the tool is not moved back so far that driving center *G* loses its contact with the work, as the proper meshing of the cutter depends on the driving connection between *G* and the blank. If *G* is ever moved back out of contact with the blank, this con-

nection is broken and when the cutter is again moved forward onto the work, it will probably be found out of step.

The action of cutter N will be readily understood now that the method of driving it has been explained. The face, which is in the plane $x—x$ of the axis of the work, as shown in the end view of Fig. 4, is the cutting edge. As the tool is forced onto the work, this revolving cutting edge, having the exact shape of the helical gear which is to engage with the work, cuts teeth of that exact shape on the blank as it is gradually forced over it. In other words, the operation

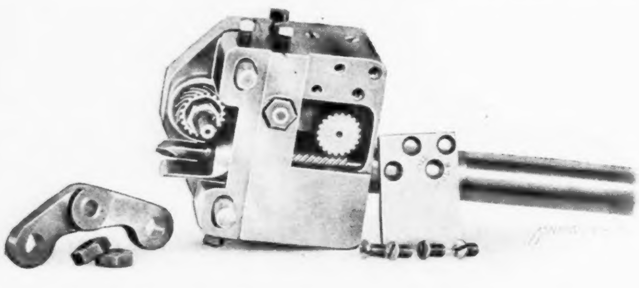


Fig. 2. Front View of the Helical Tooth Generating Tool.

is an example of the molding-generating principle, the cutter M molding the proper surface to mesh with its own teeth.

Details of Construction of Generating Tool.

The various adjustments of the tool may be understood by reference to Figures 2, 3 and 4. The shank of the tool is made very long, as may be seen also in Fig. 1. This permits the use of a spring for plunger Q long enough so that its pressure will not be materially greater when the cutter is pushed clear over the work at the completion of the cut, than when center G first enters the hole in the work. If the pressure should materially increase, there would be danger that G might be pressed further into the edge of the hole, thus disturbing the axial relation of G and the blank, and consequently throwing the cutter and the work out of step with each other by that amount. The use of the long spring avoids the possibility of trouble on this score.

The cutter spindle S is mounted in bronze bushed bearings in front and back plates T and U, which are clamped together and to the body P of the tool by studs and nuts V. These studs, as is most plainly shown in the sectional view in Fig. 4, pass through elongated slots in the body so that the cutter spindle may be adjusted for a larger or smaller diameter of work by means of set-screws W, the adjustment being locked by nuts V. This adjustment would, of course, disturb somewhat the correct meshing of gears L and M.

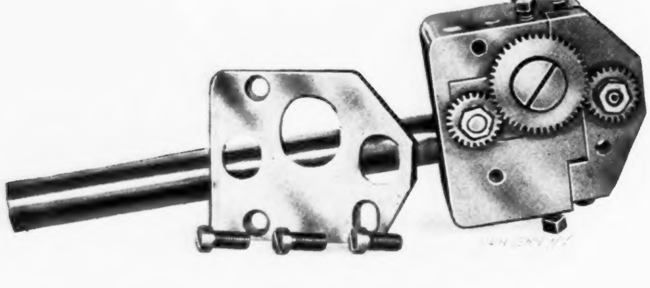


Fig. 3. Rear View of Generating Tool with Gear Guard Removed.

Gear L is therefore mounted on a stud X which floats in an enlarged hole in the body, and so may be adjusted by means of suitable set-screws which bring it into proper mesh with both M and K. The shaft on which the latter is mounted is also carried in a sliding block Y, by means of which gears J and H can be moved into closer or freer mesh. After the cutter has been set to the proper diameter for the work, the whole system of gearing may thus be adjusted to mesh without discoverable back lash and without binding. It is advisable to have as little back lash as possible between the cutter and the driving center to prevent the former from jumping or chattering when first commencing the cut. When there is much back lash the ends of the teeth where the cut commences are not formed to quite the proper shape. While there is no great harm in this in the case of a helical gear, in which the contact takes place in the center of the face, it gives a poor appearance to the work, and so should be avoided.

The thrust of the revolving work, pressing down on the cutter when the tool is in action, is taken by a ball bearing at Z. This is the only point where there would be any great danger of excessive friction so that the probability of G slipping in the work, due to too great a resistance in the mechanism it has to drive, is obviated. As was explained earlier, for the desired action, the cutting edge of the cutter must be in the plane of the center line of work. In the tool shown, no special provision is made for maintaining this condition. As the face of the cutter is sharpened it is necessary to pack it out with filling washers. In later designs,

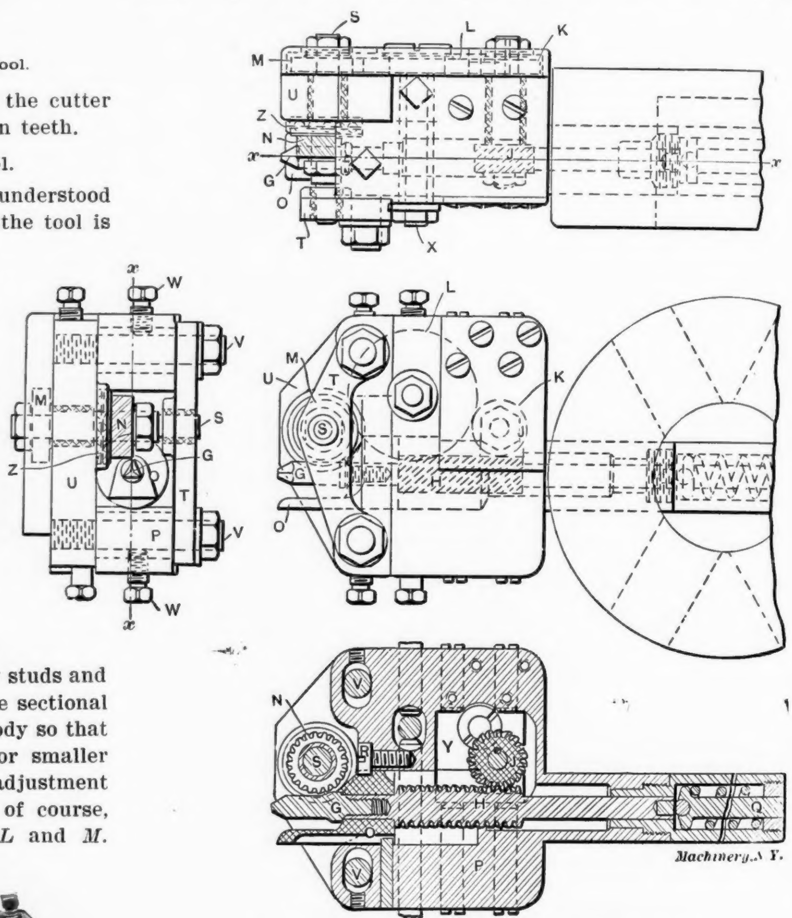


Fig. 4. Details of Construction of Generating Tool.

adjustments are provided for bringing the cutting point on a line with the center.

Order of Operations in making the Completed Gears.

The order of operations followed is shown in Fig. 5. The part to be made is shown with dimensions at the bottom of the engraving. The first operation after feeding the stock is centering and facing, as shown at A. This is done with a tool held in the turret, and shown pointing upward to the right in Fig. 1. The turret is next revolved two holes, and the drill is brought into action. Then the turret is revolved again and the hole is reamed. The reamer is mounted in a "floating holder" seen pointing downward to the left in Fig. 1 (the turret revolves in a counter clock-wise direction). This form of holder enables the reamer to be centered accurately, so that it will cut to size and take off an equal amount with all of its teeth. While the drilling and reaming are going on, the blank is being formed by a circular form tool mounted in the front cross slide, as shown at B and C. The operation of cutting the teeth at D has already been sufficiently described. At E the hole is being

counter-bored. This counter-boring incidentally removes the marks made by the sharp corners of driving center *G*. At *F* the completed piece is being severed from the bar. While the counter-boring is in progress, and during the first part of the cutting-off operation, the front form tool as shown at *E* and *F* is again brought down to clean off the burrs produced by the gear cutting tool.

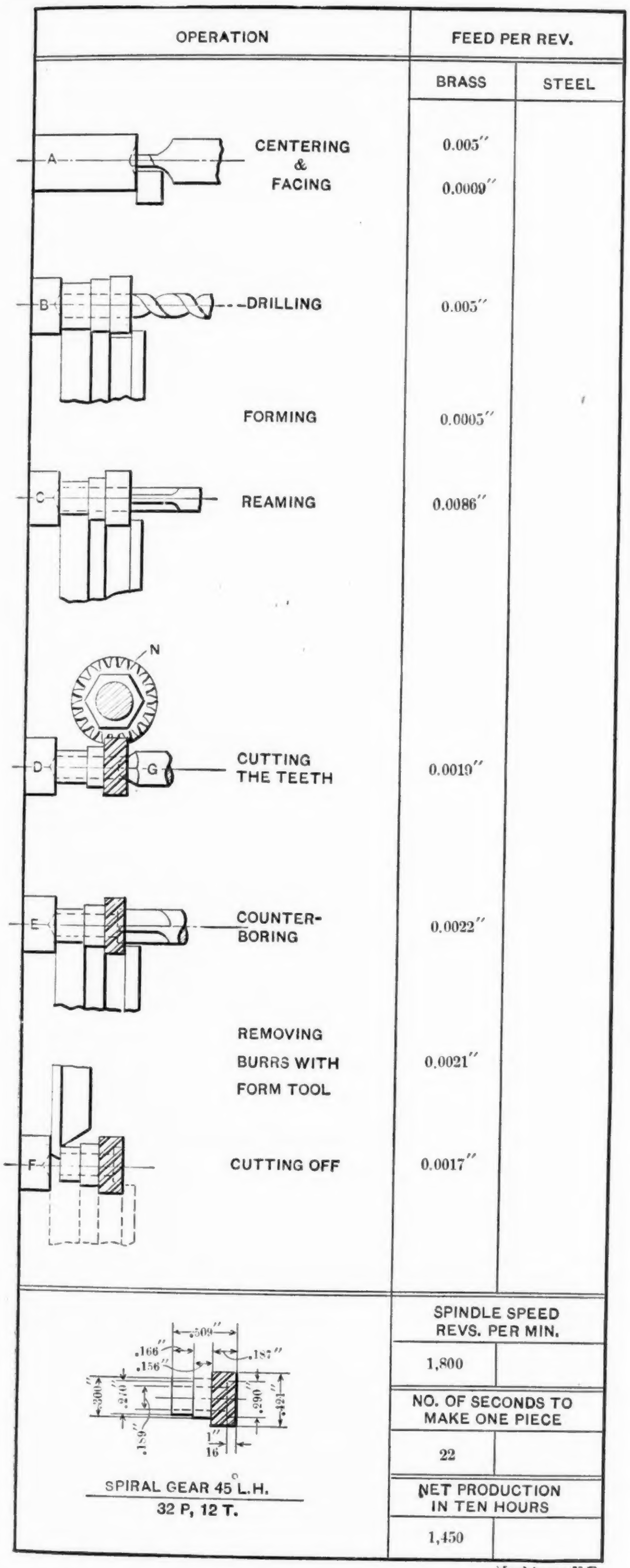


Fig. 5. The Order of Operations and Rates of Feed.

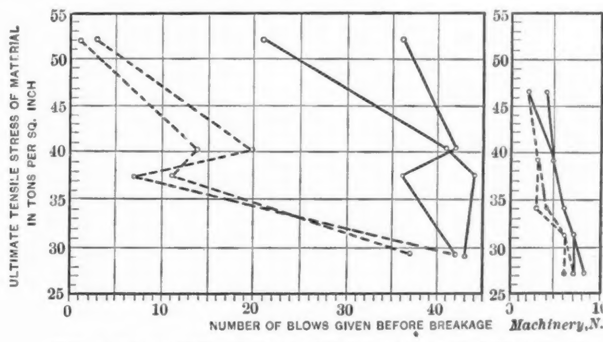
A pair of finished brass gears made by this process and mounted in a little angle plate is shown, as an initial piece at the beginning of this article. A few of these were made up to exhibit the work of this machine and the set of tools provided for it. The writer, who has one on his desk, can swear to its being a very attractive plaything. The little gears mesh smoothly with each other, and appear to be finished, on the whole, rather better than would be the case had they been shaped by a formed cutter as usual. There appears to be almost no limit to the possibilities of the automatic screw machine in the hands of a resourceful designer, and this little exhibition set of gears serves very well as a reminder of that fact. R. E. F.

* * *

COMPARISON OF STRENGTH OF THE U. S. AND THE WHITWORTH STANDARD THREADS.*

Strength is a very important feature of screw threads, and many experiments have been made with regard to it. There appears to be little doubt that bolts provided with the Whitworth thread are stronger than those provided with other standard screw threads. Experiments have been carried out in connection with the work of the Engineering Standards Committee of Great Britain, which indicate the difference in strength of the Whitworth and the U. S. or Sellers forms of screw threads. The tests were shock tests, and must be considered as conclusive, because in every case the Whitworth thread sustained a greater number of blows before fracture than the U. S. thread. The experiments were carried out by dropping a 400-pound weight through a distance of three inches, and also through a distance of twelve inches, and then recording the number of drops required before fracture occurred. In order to make the tests as authentic as possible, each set of screws compared were made from the same bar.

In the accompanying diagram, Fig. 1, are shown the results of the three-inch drop tests. The graduations on the base



Figs. 1 and 2. Shock Tests on Bolts with U. S. and Whitworth Standard Threads.

line show the number of blows given to the specimen before fracture occurred. On the scale to the left is given the ultimate tensile stress of the material from which the screws were made, in tons per square inch. It is interesting to note that the strength of the U. S. thread more nearly approaches the strength of the Whitworth thread when only mild steel is concerned; the higher the ultimate breaking stress, the greater advantage does the Whitworth form show over the U. S. form of thread. In Fig. 2 are shown the results obtained in the twelve-inch drop test. It will be noticed that in this case the difference, as a rule, is smaller, but the Whitworth thread maintains its advantages in strength, although not in so marked a degree as in the shorter drop tests.

In the diagrams, the results obtained in the tests of specimens threaded with U. S. standard thread are shown by dotted lines, and the results of the tests of specimens threaded with Whitworth thread, in full lines. The two lines shown for each indicate results of two sets of tests on eight bolts each. The results of the individual tests are shown by the small circles, and these have been connected by the lines merely to show at a glance which circles refer to the same set of experiments.

* * *

The headings of one of the twin tubes under the Hudson River, connecting New York (Hudson Terminal) and Jersey City, were joined January 27, and the event was celebrated by an official inspection trip. The approximate distance between the terminal in Jersey City and the Hudson Terminal at the foot of Cortlandt St., New York City, is 6,000 feet. It is expected that both tubes will be completed and the system in operation about July 1, 1909. The headings of the second tube were joined March 11.

* From an article by Mr. H. F. Donaldson in *Engineering*, February, 1909.

MACHINE SHOP PRACTICE.*

CYLINDRICAL GRINDING—1.

The grinding machine is one of the most useful tools found in a modern shop, for with this tool it is possible to finish a considerable variety of work in less time than is required when a lathe is used, and, in addition, the quality of finish and degree of precision attained are such as to make the production of interchangeable parts comparatively easy. The grinder is not only a tool for finishing hardened work and work requiring great accuracy, as it is widely used for finishing general machine details which have been previously roughed out in the lathe.

Cylindrical grinding machines, like milling machines, are divided into two general classes, known as plain and universal grinders. The first type is used for grinding work in large quantities, which varies comparatively little in form, which means that it is essentially a machine for manufacturing purposes. The general construction of the universal grinder is similar to that of the plain grinder, but it differs from the latter in having certain special features and auxiliary attachments which adapt it to a more general or universal class of work. Such a machine, as built by the Landis Tool Co., is illustrated in Fig. 1. With this particular type of machine, the platen *A* remains stationary, while the revolving wheel *B* is traveresd past the work, which is mounted between the centers of the head- and tail-stock *C* and *D*. The length of the stroke of the wheel carriage is regulated for

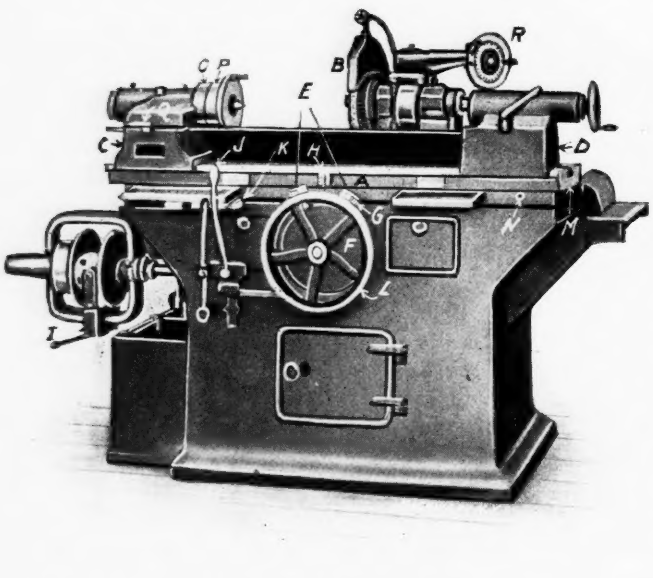


Fig. 1. A Universal Grinding Machine built by the Landis Tool Co.

work of different lengths by varying the position of the dogs *E*, which are mounted on the dog-wheel *F*. On the periphery of this wheel worm-teeth are cut, and the dogs are held in any desired position by worms *G*, which may be lifted out of engagement with the wheel when the dogs are to be moved a considerable distance. The tappet *H* against which these dogs strike, thus reversing the movement of the carriage, can be swung cut of the way when it is desired to let the dogs pass, so that the work being ground may be inspected or measured. The amount that the wheel carriage moves longitudinally per revolution of the work is regulated by changing the position of the lever *I*. The lever *J* is used for reversing the carriage at any point, by hand, while the traverse is started or stopped by lever *K*. When it is desired to move the carriage longitudinally by hand, the wheel *L* is used. The platen *A* may be swiveled about a central stud when grinding taper work between the centers, unless the taper be too great, when the lower wheel slide is set to the required angle. There are two sets of graduations on the end *M* of the platen, one giving degrees and the other the taper (by eighths) in inches per foot. It might be mentioned that the graduations on grinding machines are only intended to give an approximate setting, gages and micrometers being used to test the accuracy of both taper and straight work. When slight adjustments of the platen are found necessary, the fine adjusting screw *N* is used. It will be noticed that there are two pulleys *O* and *P* mounted on the head-stock. The first is for driving the head-stock spindle when grinding work held in a chuck (which replaces the pulley *P*) or when driving large work held between the centers; but as it is advantageous to grind most work on dead or stationary centers the loose pulley *P* is provided, which simply revolves upon the head-stock spindle, which is then locked. The object of grinding work while it revolves on stationary centers is to secure accuracy, as then any slight error which may be in the spindle bearings is not reproduced in the work. As it is often necessary to grind the sides of milling cutters, disks, etc., which must be held in the chuck, the head-stock is made to swivel and is provided at *Q* with graduations in degrees. The emery wheel is moved to or from the work by the hand-wheel *R*, which is graduated to indicate reductions of 0.001 inch in the diameter of the work. In conjunction

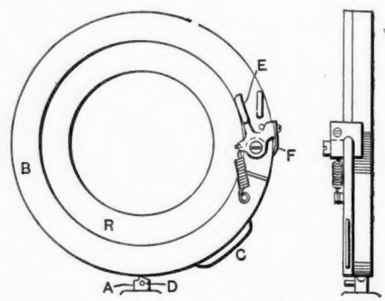


Fig. 2. Mechanism for Setting the Automatic Feed to grind any Predetermined Amount.

with this hand-wheel there is a feed which is actuated at the end of each stroke and which may be set to advance the wheel at each reversal from 0.000125 to 0.0025 of an inch; the corresponding reductions in the diameter of the work are, of course, equal to twice this amount. This feed is effected by the pawl *A* (Fig. 2) which meshes with ratchet teeth in the periphery of the wheel *R*. Provision is made for automatically disengaging this feed when the wheel has ground any predetermined amount (within 0.00025) from the work. This is accomplished by a removable ring *B*, mounted on the hand-wheel, which has attached to it a knock-out cam *C*, which engages with the pin *D* on the pawl *A*. When setting this feed to grind a given amount, the wheel is first brought into contact with the work, by turning the hand-wheel *R*; the ring *B* is then moved around until the cam *C* is against the pin on the pawl *A*. As the machine makes its first stroke the pawl is disengaged from the ratchet. The wheel should then be allowed to pass over the work until it has practically ceased cutting, when the traverse should be stopped, say at the foot-stock end. The diameter of the work is next measured carefully with a micrometer. The thumb-latch *E* is then pressed against its stop four times for each 0.001 inch reduction in diameter required. As this thumb-latch has attached to it a spring pawl *F* which engages with the ratchet teeth on the wheel *R*, the ring *B*, with its knock-out cam, is moved away from the pawl, each time the latch is pressed an amount equivalent to one ratchet tooth, which means that the emery wheel will be fed in 0.000125 inch farther before the feed is automatically thrown out. Hence the latch is pressed once for each 0.00025 inch reduction in diameter required. After the feed is set to grind the required amount, the cut should be continued until the wheel has practically ceased cutting, when it should be stopped at the foot stock end as before, and the work again measured. If the wheel used is adapted to the work, and the relative speed of wheel and work are at least approximately correct, the reduction in diameter will be equivalent to that for which the feed was previously set, providing the amount of metal removed is not too great, for in that case the work will be large, owing to the wear of the wheel.

If satisfactory work is to be done in the grinder, it is absolutely essential that the grinding wheel be of a grade and grain which is best adapted to the material to be ground. Grinding wheels are composed of a large number of grains or kernels of some suitable abrasive material, such as alundum or corundum, which are held together by what is known as a bond. By varying the amount of this bond, wheels of different grades are obtained. The term grade does not refer to the degree of hardness of the abrasive, but to the

* With Shop Operation Sheet Supplement.

tenacity with which the bond holds the grit in place, and it is designated by the letters of the alphabet; *A* being extremely soft, *M* medium, etc. The grain or coarseness of a wheel is designated by numbers which indicate the number of meshes to the square-inch through which the kernels of grit will pass. The degree of hardness and the kind of material to be ground are factors which determine the grade and grain of a wheel. For example, machinery steel requires a harder wheel than does hardened tool steel. The reason for this will perhaps be better understood if we think of an emery wheel as a cutter having attached to its periphery an innumerable number of small teeth, for this is literally what the thousands of small grains of abrasive are. When the wheel is of the proper grade, these small teeth or kernels of grit are held in place by the bond until they become slightly dulled, when they are torn out of place by the increased friction. Obviously, these grains or cutters will become dulled sooner when grinding hard than when grinding soft steel; hence the harder the material the softer the wheel, and *vice versa*. When a hard wheel is used for grinding hard material the grit becomes dulled, but it is not dislodged as rapidly as it should be, with the result that the periphery of the wheel is worn smooth or glazed, so that grinding is impossible without excessive wheel pressure. Soft materials, such as brass, however, are ground with a soft wheel, which crumbles easily, thus preventing the wheel from becoming loaded or clogged with metal, as would be the case were a hard-bonded wheel used. When a wheel is used which is too soft, the wear is, of course, greatly increased, as the particles of grit are dislodged too rapidly, and consequently the wheel is always "sharp." This means that the abrasive has not done sufficient work to become even slightly dulled, and the result is a rough surface on the work.

The area of the surface which is in contact with the wheel is also a factor which should be considered when selecting the proper grade. As the contact area increases as the diameter of the work increases, the wheel should be correspondingly softer because the grit is more quickly dulled by this greater contact. The grain or degree of coarseness of the wheel is another item which should be considered in making a selection. Generally speaking, coarse wheels are better adapted to most work, as deeper cuts may be taken, and, in addition, the work is kept cooler because of their porosity. When a very fine finish is required, however, particularly on a number of duplicate pieces, fine wheels are often used to advantage for finishing, after the work has been ground to within, say 0.003 inch of the required size, with a coarse wheel. If little stock is to be removed from a hard surface, however, the coarse wheel could be dispensed with and a fine wheel used to advantage, as the wear of such a wheel is less, though the tendency to burn the work is greater, as the water (a copious supply of which should always be used) does not reach the grinding parts so easily. There is, of course, an advantage in using one wheel for both roughing and finishing, and a coarse wheel, say of 36 grain, will produce a finish fine enough for most purposes, if the work speed is reduced somewhat, and the wheel is trued with the diamond just before taking the finishing cuts.

Proper preparation of the work is another important item in connection with grinding which should be considered. The machine centers should be accurately ground to an angle of 60 degrees, but it is also essential that the centers in the work be true, to the proper angle, and clean when the work is placed in position. Parts which have been hardened (such as the mandrel illustrated in the Shop Operation Sheet accompanying this issue) prior to grinding, are occasionally so distorted by this hardening process that they cannot be finished to the required size. Straightening can then be resorted to, but this should not be done while the work is cold, as there is always a tendency for it to resume the original shape, owing to internal strains, and even if properly heated there is more or less danger of such distortion. When necessary to straighten hardened work it should always be heated, though not enough to anneal it, and then straightened in a press. By proper annealing prior to the hardening process the tendency of the work to spring out of shape is often overcome. This annealing, which releases the internal strains incident to the rolling or forging operations, should take place after the outer surface has been removed in the lathe, then if the work when tested runs practically true it may be machined to the grinding size, which, for a mandrel such as illustrated on the Shop Operation Sheet referred to, would be about 0.010 or 0.012 inch above the finish size. If, however, the test should show that the piece was badly warped, it should be heated to a cherry red, straightened, and then annealed as before.

Whenever possible, grinding should be the last operation performed so that the work will not be marred or sprung out of true. Key-ways in shafts, etc., should invariably be finished prior to grinding, as the removal of metal for the key-way from one side of the shaft will often distort the latter. The machine itself should be carefully examined frequently, as its efficiency often depends upon a little intelligent care. The bearings of the head- and tail-stock spindles, and particularly those of the wheel spindle, should be carefully adjusted to eliminate all lost motion, and the cross-slide for the wheel should also be adjusted and oiled so that there will be that perfect freedom of movement which is necessary if this part, as is often required, is to move as little as one-eighth of one-thousandth of an inch with accuracy.

A continuation of this article will appear in the May issue, which will also be accompanied by a Shop Operation Sheet giving an example of cylindrical grinding.

* * *

THE PUNCH THAT WAS "PINCHED."

C. TUELLS.

Jim was master mechanic at the old novelty shop when it was located just back of Chinatown in the dirtiest section of one of Boston's poorest streets. The novelty shop made most anything that could be made cheaply with sheet brass and

"Running up the street at full speed was a ragged urchin with Jim's punch in his hand."

punch presses, and many were the ragged youngsters who played under its windows and went through the scrap barrels for souvenirs.

Although Jim was master mechanic he didn't travel around the shop with a slide rule in his hand, figuring out speeds and timing the presses, and looking for trouble in general. Jim's trouble all came to him, for all the mechanical work of the shop between the toolmaker and the presshands fell at his door; in fact Jim was the general utility man of the press room. If a punch needed grinding, Jim ground it; if a die was to be set, Jim set it; if a countershaft needed adjusting, why send for Jim, of course.

The novelty shop was a small affair, and the tool room was in proportion; one toolmaker did all the work, but when

times were good he sometimes had to turn up his sub-press pins while the shaper was running a long cut over a die blank in order to keep ahead of the job.

Well, one day Jim was setting up a new die in the punch-press, and, like every other new job, a few little things had to be done before the punchings came out satisfactory, and among these things half an inch had to be sawed off the end of the punch shank, which was, as the Irishman said, "too long on one end." It was only nine-sixteenths inch diameter, so Jim, anxious to get the job going, hustled over to his bench vise, gripped the punch and started his hack-saw going to the tune of "Yankee Doodle," one eye on his work and the other through an open window on a group of ragamuffins playing tag in the street below.

Jim was in a hurry. He thought (as we all thought once) it would be quicker to break the last quarter-inch, so holding the surplus end that he *did not want* in the vise, he hit the punch a much misjudged and mighty blow with his two-pound hammer. It broke—and the punch went sailing through the window into the middle of the street.

Jim looked out the window just in time to be too late, for running up the street at full speed was a ragged urchin with Jim's punch in his hand, and a broad grin on his face.

Pursuit was useless, for before Jim could get to the street the boy was out of sight, and most of his comrades as well. The punch never came back. After trying to explain the situation to the boss, the toolmaker, much to his disgust, had to drop everything and put in the rest of the day getting out a new punch.

Jim is wondering to this day whether that punch found its way to the cupola of some iron foundry by way of the "junky," or if it still reposes among that particular youngster's treasures. Jim now holds the end of the punch that he *wants* in the vise before breaking, because—well, "there's a reason."

* * *

POWER OF INSURANCE COMPANIES TO IMPROVE LIVING CONDITIONS.

The power of the casualty insurance companies of the United States is being employed to improve the working conditions in factories and reduce the great number of accidents to life and limb that makes America an industrial slaughter house. A further development of the great work of the insurance companies in this line, of much broader scope, is proposed, which is hoped will improve living conditions and materially increase human longevity. It has been shown by the work of Col. Gorgas in Havana, Cuba, that the improvement in sanitation tremendously decreased the death rate. The death rate in Havana was cut in two, being brought down to about twenty-four deaths per thousand per year. In New York City it was materially decreased by Col. Waring's street cleaning crusade. Of course, it is to the material advantage of the casualty and life insurance companies to reduce the number of accidents in manufacturing establishments and to improve general sanitary conditions throughout the country, and this work of enormous scope, if undertaken, would be undertaken on the basis of good business policy alone. The life companies may aim to stamp out the great scourges, typhoid fever and tuberculosis, both preventable, one being caused almost entirely by infected drinking water and the other by bad housing. The reduction of accidents and increase in length of life would reduce the amount of claims and increase profits, but all true philanthropy has practically the same result. The improvement of living of the poorer classes reacts favorably on general conditions and increases common prosperity.

* * *

A novelty which has come into use in a number of British drafting-rooms is the employment of "cross-section" tracing cloth for detail drawings. The tracing cloth is ruled with vertical and horizontal lines one-eighth of an inch apart, in the same manner as ordinary cross-section sketching paper. It is claimed that the use of this kind of tracing cloth is the source of considerable saving in time, as it is easier to terminate lines at correct points and it makes it possible to draw simple details directly on the tracing cloth.

IMPROVEMENTS IN HIGH-SPEED STEEL.

Recent advances in the manufacture of high-speed steel have enabled the Firth-Sterling Steel Co., of McKeesport, Pa., to obtain results with their "Blue Chip" steel in every-day machine shop work, which are believed by the makers to mark a definite advance in machine shop practice. These improvements have resulted in a steel that is less affected by the heat of the cutting action, and so is capable of increased cutting speed and longer life. For finishing cuts on fine-grained metals, it is hardened in air or in oil, though for roughing work, or cuts in coarse-grained metals in general such as cast iron, it can be quenched in water the same as old-fashioned tool steel. For hardening, it is heated to the extremely high temperature required by all high speed steels.

To bring the advantages of this new product to the attention of manufacturers, Wheelock, Lovejoy & Co., of Boston, Mass., and New York City, agents for the Firth-Sterling Steel Co., have been giving exhibitions of its work in Worcester and Springfield, Mass., and Providence, R. I. The three half-tone engravings shown herewith were made from photographs taken in the plant of the Baush Machine Tool Co., where the Springfield exhibition was held. In Figs. 1 and 2 is shown the "Lo-swing" lathe (built by the Fitchburg Machine Works, Fitchburg, Mass.) engaged in rough turning spindles for a large size of the Baush multiple spindle drill. These spindles are of 45-point carbon steel and have the dimensions shown in the sketch in Fig. 3. The "Lo-swing" lathe, as is well known, is particularly adapted to the rapid turning of bar stock, being arranged to use as many tools for this work as may be required by the number of diameters and

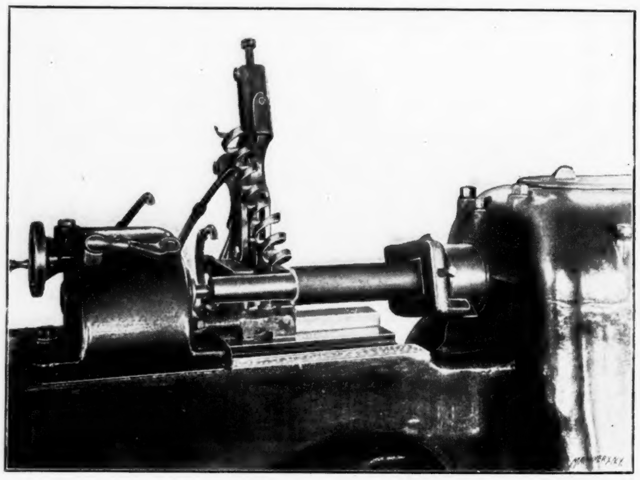


Fig. 1. Taking a Stiff Chip on the "Lo-Swing" Lathe with "Blue Chip" Steel.

shoulders to be turned. In the case shown two chips are taken, the first reducing from 2¾ inches to 1¾ inch, and the second making a further reduction to 1½ inch for a short distance, as shown in Fig. 3. The rear of the lathe, in Fig. 1, shows the work just before the second tool comes into action, while Fig. 2, taken from the front of the machine, shows the conditions at the completion of the cut. The figures given for this cut in 45-point carbon steel are: 165 revolutions per minute, giving a surface speed of about 120 feet per minute; feed, 75 revolutions per inch; length of time required for taking cut, about 4 minutes and 50 seconds. These feeds and speeds on this metal are claimed by the makers of the steel and the builders of the lathe to be obtainable in common, every-day practice. Results much more spectacular than these could be and have been obtained for exhibition work, but they are not considered practicable for recommendation as standard shop practice.

The steel makers state that the "Lo-swing" lathe was selected for this test because it is capable of putting a lathe tool to more severe service than any other machine that had been met in their experience in selling tool steels. They, in common with other makers, had been put on their mettle in furnishing cutting tools which came up to the possibilities of this machine. The way in which the work and the tool are tied together, and the rigid support for both, make the action one of pure cutting only, so the size of chip taken is

limited purely by the heat resisting qualities of the metal and the strength of the work, instead of by the breaking of the cutting edge from chattering and vibration, as is common in the standard lathe. Of course, cuts comparable with that here described have been taken from heavy forgings on lathes of great size and weight, but the size of the machine employed should be taken into account in making comparisons.

An improvement in a tool steel which increases its capacity of resistance to heat gives it a greater advantage than is

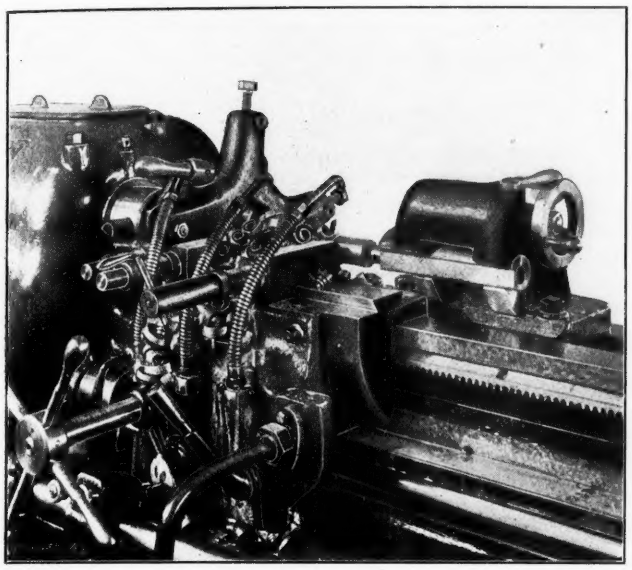


Fig. 2. Front View of Lathe at Conclusion of Cut.

indicated by this fact alone. A tool deteriorates, so far as heating is concerned, from the fact that it is unable to carry the heat away fast enough through the blade and shank to prevent the cutting edge from reaching a dangerous temperature. This heat-carrying capacity may be increased by using a blunt cutting edge, which furnishes a larger body of conducting material for the blade. Owing to the heat-resisting qualities of the improved steel, this cutting angle can be greatly reduced, making the action more knife-like. This, in turn, reduces the heat generated per cubic inch of metal removed, since less work is done in shearing the metal, the action being more nearly the ideal one of slicing it off. This advantage of the sharper cutting angle gives the further advantage of less power consumption per cubic inch of metal removed per hour, so that there is a gain in every direction. In the particular lathe shown, also, it should be considered that the design is such as to permit the use of more acute cutting angles with any steel than is ordinarily possible with the standard lathe.

An interesting point as to the use of water or other cooling compounds for turning, was mentioned by Mr. Juthe, who had charge of the exhibition. This relates to the most effect-

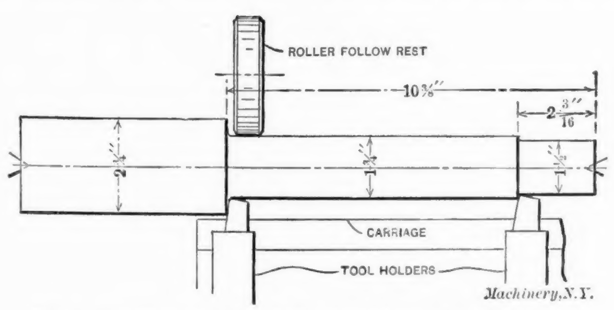


Fig. 3. Dimension of Work and Arrangement of Tools in Fig. 2.

ive point to apply the cooling liquid. Mr. Fred W. Taylor advises that it be directed on top of the chip, over the top face of the tool. In work of the kind here illustrated, however, it has been found that the important point is to keep the work itself cool. If the tool is cutting in cold metal, its action is satisfactory and the edge is durable. If, however, it is cutting in metal already highly heated, it has been found impossible to cool it properly by directing the stream against the already severed chip. That the plentiful supply of cooling liquid furnished in the machine shown is effectual in cooling the work is evidenced by the fact that it is not found necessary to readjust the tail-center during the course of a high-speed cut in which much heat is generated.

Fig. 4 shows an unusually interesting planer, which was also used at this same exhibition. This planer is built by the Powell Tool Co., of Worcester, Mass., and employs the ingenious principle of an accelerated speed *on the cutting stroke*. So far as we know, this is the first planer built employing this principle. In action, the cutting tool first enters the work at the ordinary cutting speed or slightly less, and, when well started, is accelerated to a much faster rate of travel. At the end, before running out of the metal, it is again slowed down to the medium speed just before reverse. This has the advantage of starting in a heavy cut slowly, without danger of breaking the tool, and still permitting the highest practicable speeds to be taken during the main part of the cutting action. The slowing down before the cut runs out has the advantage of preventing the breaking out at the ends which is otherwise inevitable on heavy cuts. For the occasional work in which the cut is not continuous, but passes over a succession of cuts with intervening clear spaces, the accelerated mechanism may be thrown out by the simple shifting of a lever, permitting the planer to operate in the ordinary way. The increasing of the speed during the cutting action increases the output of the planer very greatly, as compared with the increase obtained by accelerating the return stroke, to which the most attention has been given by designers of planers. The accelerating mechanism is of very simple construction and does not require an extra belt. The design appears to have been worked out in a very simple and effective manner.

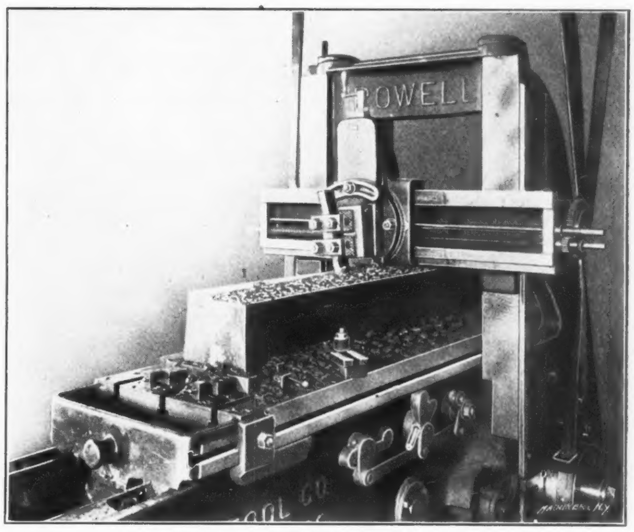


Fig. 4. The Powell Accelerating Cut Planer.

It will be interesting to compare the steel exhibited at this demonstration with the new English water-hardened tool steels, about which so much has been written lately, as soon as the latter reach the American market, and are used sufficiently to get a thorough understanding of their capabilities.

* * *

A large hydro-electric power plant will be erected by the Grand Falls Power Co. on the St. Johns River at Grand Falls, New Brunswick. The contract for the construction work has recently been placed with the Frank B. Gilbreth organization of New York. The plant will generate 100,000 H. P. electric current, which, it is stated, will be furnished to cities in New Brunswick and Maine. The work involves the construction of a number of shafts in rock excavation 130 feet deep, a power chamber 30 x 260 feet and 130 feet deep, and a tail race tunnel 28 feet in diameter and 2,400 feet long, and also a power house 350 x 260 feet. The intake shafts will be nine in number, the diameter of each being 12 feet. The total head developed at this place is 135 feet. Numerous auxiliary structures, sub-stations, and long distance transmission lines will also be erected and the total expenditure is estimated at over $5,000,000.

LETTERS UPON PRACTICAL SUBJECTS.

Articles contributed to MACHINERY with the expectation of payment must be submitted exclusively.

CHART FOR THE COST OR PURCHASING DEPARTMENT.

The accompanying chart is very useful in the drafting-room, cost, or purchasing departments. When ordering stock or checking up to see if enough material is on hand, a glance from the drawing to the chart is all that is needed. The inner circle of figures is for the length in inches of the piece required; while the figures on the outside give the number of linear feet of stock necessary to make 100 pieces.

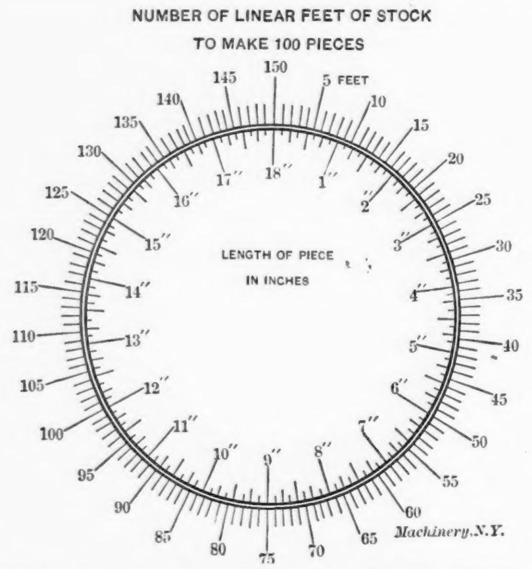


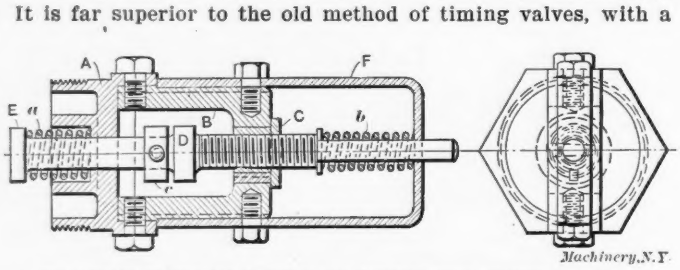
Chart by which the Number of Linear Feet of Stock required for a Number of Pieces of given Length, may be determined.

For example, if the length of a piece as per order, is $2\frac{7}{8}$ inches, and there is an allowance for cutting off of $\frac{1}{8}$ inch, the total length of the piece would be 3 inches. By locating the figure in the outer circle which is opposite the figure 3 in the inner circle, we find that the required number of feet for making 100 pieces is 25; having this, the amount of stock for any number of pieces may easily be determined.

Rochester, N. Y. RALPH W. DAVIS.

VALVE TIMING GAGE FOR AUTOMOBILE MOTORS.

The valve-timing gage, shown in the engraving, has been in use for some time and has been found very satisfactory. It is far superior to the old method of timing valves, with a



Gage for Obtaining the Opening and Closing Point, Relative to the Fly-wheel, of the Valves on Automobile Motors.

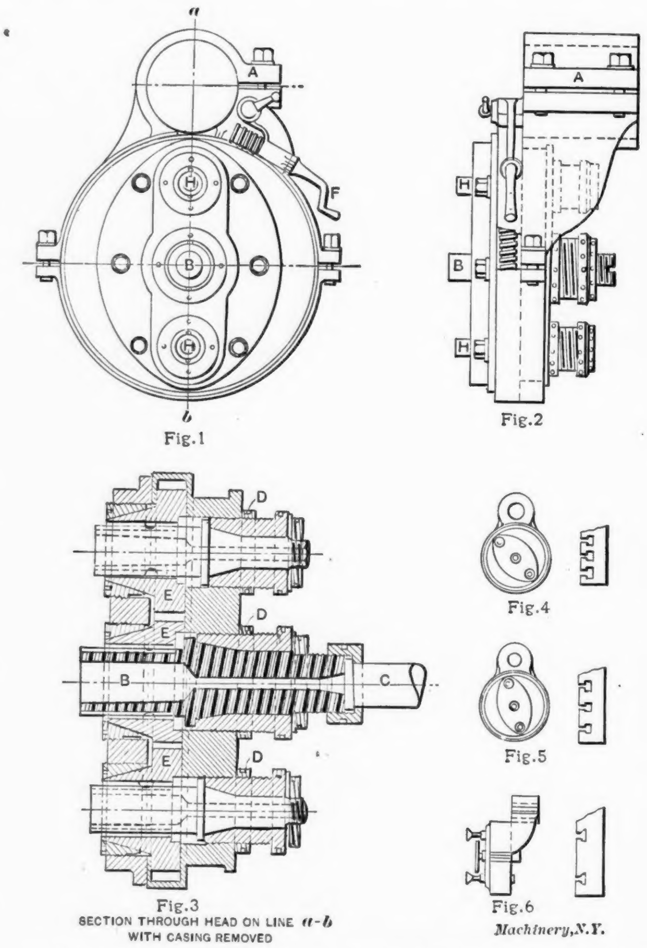
screw driver. With this gage the exact opening and closing of the valve, relative to the fly-wheel, can readily be determined. The body *A* is made to fit the valve plug hole in the cylinder head of the motor. *B* is a guide for bushing *C* which is keyed to keep it from turning when spindle *D* is adjusted. Bushing *C* must be a slide fit in guide *B*. Spindle *E* is held in contact with the valve head by spring *a*. *F* acts as a guide for the upper part of spindle *D* and also holds spring *b* in position. The construction of the gage can readily be understood by referring to the engraving.

When the gage is to be applied to an engine it is threaded into the cylinder valve-plug hole, and the spindle *D* is adjusted until a thin piece of paper can freely move between the collar *c* and the spindle *D*. This should be done when valve to be timed is closed. The fly-wheel of the motor is then turned very slowly until the paper is held tight between *c* and *D*; but the bushing *C* should still be seated on the guide *B*. A point is then marked on the fly-wheel for the valve opening. The fly-wheel is again turned slowly in the same direction, while pulling on the paper, until the paper is released; this will indicate the closing of the valve. These points are numbered on the fly-wheel according to the number of the cylinder timed.

St. Louis, Missouri. C. T. SCHAEFER.

A THREE-SPINDLE MILLING ATTACHMENT.

A three-spindle attachment for the milling machine is shown in the accompanying drawing, where Figs. 1 and 2 represent the front and side elevations of the complete device, while Fig. 3 is a sectional view. The device is clamped to the milling machine by fastening the bracket *A* to the overhanging arm. The central or main spindle *B* is driven by the spindle of the machine to which the head is attached, by means of the taper arbor *C* which is fastened to the spindle of the attachment by a locking cap, as shown in Fig. 3. Each of the three spindles has an independent longitudinal adjustment. This adjustment is made by screwing the rear bearing in or out of the housing, as the work may require. The spindles are locked in place by the check-nuts *D*. The small spindles *H* are driven from the main spindle



An Attachment with Spindles having an Angular Adjustment for Varying the Distance between T-slots, etc.

by the gears *E*. Figs. 1 and 2 show part of the supporting bracket cut away in order to expose the worm-wheel and worm which are used for rotating the spindles *H* about the main spindle *B*, by turning the handle *F*. The latter is provided with graduations which read to minutes, for measuring the angular adjustment of the spindles. Figs. 4 and 5 show the attachment set for cutting three T-slots, which, in one case, are close together, and in the other further apart. The rotation of the head is sufficient to obtain a considerable

variation in the distance between slots. Fig. 6 shows the device as equipped for cutting dovetails, finishing the several surfaces at one cut. Various forms of dovetails, T-slots, grooves, etc., can be worked out in similar fashion. Obviously, the same cutters may be used in many cases for milling parts which are to fit together, a slight rotation of the head giving the necessary play in the finished piece. The same method can be employed for compensating for wear, or allowing for a reduction in size by grinding. The cutters for these different purposes may, of course, be of various sizes, and the one on the main spindle will differ from those on the outer spindles in that it will be cut to the opposite hand. This attachment will be found to be more useful for factory than jobbing purposes, and where any amount of such work, as illustrated in Figs. 4 to 6, is being done it will be found to greatly reduce the labor cost of production as compared with the old single spindle method.

Washington, D. C. G. ROBERT O'NEAL.

SOLUTION OF THE CASTING PUZZLE.

In MACHINERY for January, there appeared a short article descriptive of a casting puzzle. The engravings accompanying it showed a brake ratchet with a loose bushing, flanged on each side, cast in the center of the pawl. The usual method of making castings of the kind in question, is to first cast the bushing, as shown in Fig. 1, clean it, coat it with graphite, and place it in the mold in which the piece to

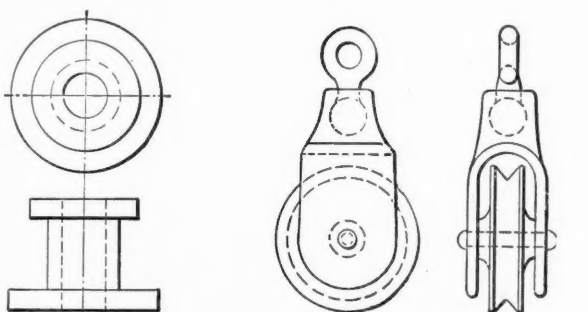


Fig. 1 Fig. 2 Machinery, N.Y.

Figs. 1 and 2. Bushing around which Pawl is cast, and Sheave and Block which are cast together.

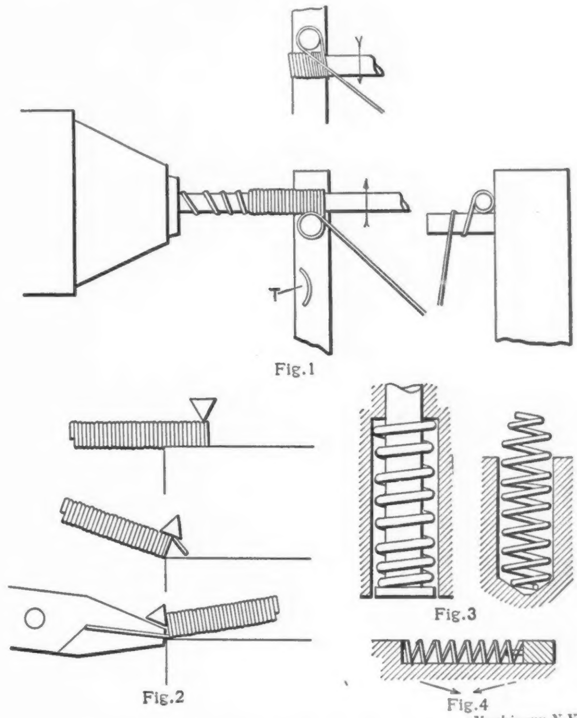
surround it is to be cast, in the same manner as an ordinary baked sand core would be placed. The coating of graphite prevents the molten metal from adhering to its surface. A little observation shows that castings of this kind are more common than is generally supposed. Pulley blocks of the type shown in Fig. 2 are a fair example of the class of casting referred to. They are commonly used for stretching clothes lines or for similar purposes, and retail at 10 cents each.

JAMES CRAN.

Plainfield, N. J.

WINDING SPRINGS.

I have used, for some time past, a tool for winding springs with initial tension which is not only effective, but is much simpler and more convenient than the one described by Mr. Viall in the February issue. With this tool, springs can be wound without any gearing up or bother other than to put a drill chuck in the spindle and clamp a tool in the tool-post. I keep a piece of steel with my lathe tools of the same size as the tools, and use it principally as a rest for the hand tools and polishing sticks, when working out punch and die contours, and for several other purposes. This tool has several holes in it in various positions, some of them tapped and others blank. One of these holes serves to hold a quarter-inch pin that is used when winding springs. Fig. 1 shows this tool in use, and it should be noticed, in particular, that it is set at such a height and in such a position that the spring mandrel is well supported. With this tool, right- or left-hand springs can be coiled and the lathe may be run forward or backward. As before stated, it is not necessary to gear the lathe, but if this were done, the lead should not be a few thousandths more or less than the size of the wire, but theoretically just that size; as it would not come out just right anyway on a long spring. My method is to throw in the nearest carriage feed, set the compound rest parallel to the ways, and with it take up the difference between the wire lead and the feed of the carriage. It makes little difference whether the wire leads off the pin exactly in line with the last coil, a little ahead of it, or three or four coils behind; and if the spindle speed is not too high it is easy to make the necessary adjustment with the com-



Figs. 1 to 4. Methods of Winding and Fitting Springs.

pound rest. At T is illustrated the set given to the wire in rounding the post, which gives it the initial tension—it is really a spring coiled against itself.

There are several other things about coiled springs that come to my mind which may be of interest. Eyes for the springs may be formed over the sharp edge of a vise or plate with a three-cornered scraper or file ground smooth. This work, which is done in three stages, as illustrated in Fig. 2, is accomplished quickly, and a very neat and square eye is the result. When a number of springs are to be made alike, I count the coils by drawing the edge of the scraper along the length of the spring, allowing one coil for the eye, and then press the scraper down, as illustrated. By keeping the eye already formed on the end in the proper position, all the springs will come out with a full eye and all eyes will bear the proper relation to one another, all being alike or half-quartered one way and half the other, as desired. When springs are always wrong there is usually a good reason. The spring A in Fig. 5 will lie flat and stay on its pins. Spring B is adapted

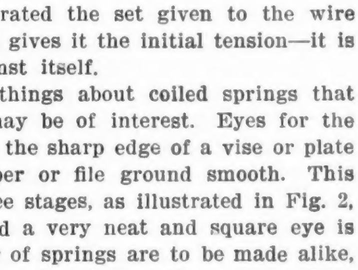


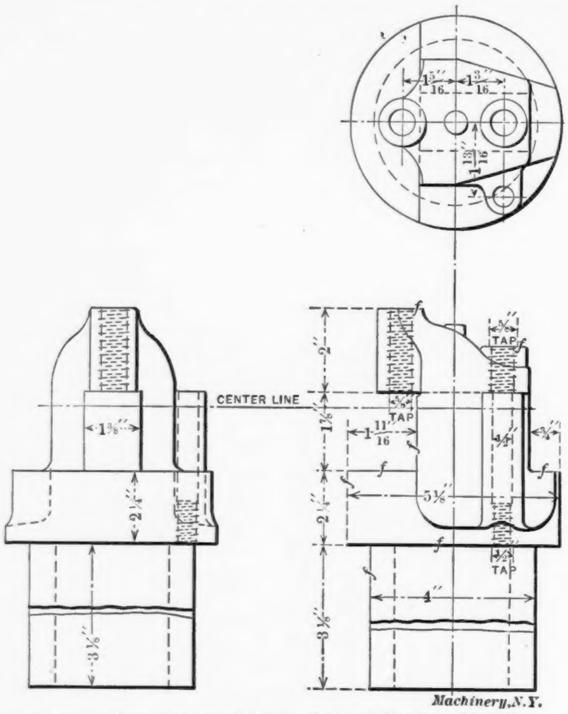
Fig. 5. Springs having Eyes located with Reference to the Retaining Pins.

to pins in different planes, but if used instead of A it will probably be necessary to make another soon for want of the original. Sometimes a spring should act both torsionally and in tension; then one like C will answer if given sufficient twist before it is pinned in place. Compression springs are more often used in this way. When fitting a compression spring over a stem and in a hole, close the end that thrusts against the stem until it is a tight fit and is fairly central, and open the end that bears in the hole until it also is a good and a central fit, as indicated in Fig. 3. If the spring is heavy grind the ends about square. When

springs are fitted in this way the stem is not chewed in half, and dust from the holes does not clog other working parts. In fact, the spring is just as good and works as freely at the end of a year as when new. Fig. 4 shows a spring that was used continuously and had to be replaced often and quickly. Many schemes were tried in order to keep it in place and at the same time have it accessible. By cutting the ends so that they both bore on top and placing the spring as shown, the thrust kept it in place and the spring was easily removed and replaced when necessary. When grinding heavy springs to square them, do not quench them when they are red hot, or you may have trouble in getting out those same ends after they have broken and done some damage. SIRIUS.

ELEVATING TOOL-POST DESIGN.

In the February number of MACHINERY under the title "Changing Old Lathe to Increase Cutting Value" an article appears which lays particular stress on the so-called "new" design of tool-post. The tool-post, as outlined, almost to the identical dimensions, was first used by us in 1883, under patent rights purchased from Mr. Lipe. We continued its use under



Elevating Tool-post used by the Bullard Machine Tool Co.

the patent, exclusively, until about 1897-8, when the patent expired. Blue-print of our shop drawing No. 23, March 15, 1883, (reproduced herewith) will show that the designs of the two tool-posts are practically identical.

S. H. BULLARD, Vice-President
Bridgeport, Conn. Bullard Machine Tool Co.

[The contributor of the article in question did not claim that the design was new, and the title to the illustration, Fig. 2, was unfortunately worded. Its meaning is that the illustration shows the *new* tool-post that was substituted for the old one, and not that it is of new *design*.—EDITOR.]

USE OF BOW-DRILL IN THE MANUFACTURE OF KNIVES.

That a curiosity like the hour glass finds a place in modern manufacturing, as cited in the January issue of MACHINERY, is an instance of how the mechanical world in its ceaseless striving for the improved, will turn to the records of the past and take from them and adapt to present-day use some primitive mechanism long since discarded and forgotten. A parallel case is found in the employment of the prehistoric bow-drill, of the North American Indians, in certain knife factories. Probably few of us ever give a second thought to the initial plate inserted in the handles of our pocket knives. In cutting the recess for these the bow-drill works with a neatness and dispatch that surprises one. More intricate shapes demand a more laborious process, but the simpler ones, such as ovals, round-ended oblongs, and other forms not requiring sharp corners, are mortised out with the bow-drill. The spindle carries in its lower end a chuck in which is held a tool made of two prongs of steel much like a tuning fork but sharpened and pointed so as to fly outward with the centrifugal force generated by the revolution. A metal templet having a hole the size and shape of the recess to be cut, is placed over the wooden handle which is gripped in a special

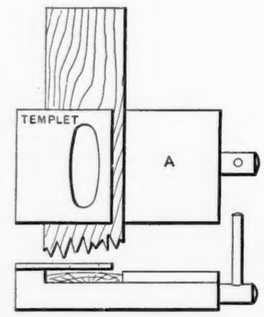


Fig. 1. Vise and Templet with Handle in Position.

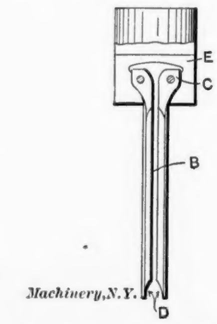


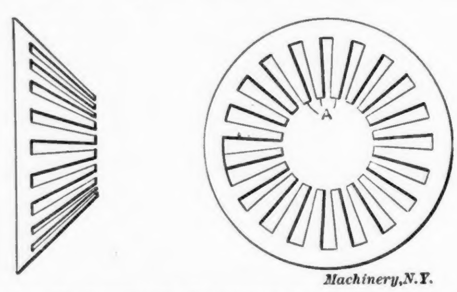
Fig. 2. Centrifugal Cutter which is controlled by the Templet.

vise *A*. Then the operator, usually a boy, grasps the bow-drill in both hands, gives the bow a couple of vigorous pulls, meanwhile imparting a slight longitudinal swinging motion in the direction of greatest length, and produces almost instantaneously a hole which is the counterpart of that in the templet. The cutters *B* are made from a piece of rectangular stock turned the full length, except that part which fits in the slot of the chuck or socket. After the pivot pin holes *C* have been drilled, the piece is split in two and it is then ready for tempering. Cutting edges are formed on the lower ends by grinding the inside, as shown at *D*. But a small part of this sharp end touches the templet, so that the wear of the templet and cutters is hardly more than would occur between two unbroken hardened surfaces running at the same rate. To cause the points to spread more readily, a spring acting in the same manner as a caliper spring is slipped over the upper ends, as shown at *E*. Except for the purpose mentioned above, the bow-drill is, for the most part, merely a museum curiosity, yet for this mortising of knife handles it holds its own and gives complete satisfaction.

Middletown, N. Y. DONALD A. HAMPSON.

TO KEEP AN ANGULAR REAMER FROM CHATTERING.

We have a 45-degree reamer which is used for reaming valve seats in our cut-out valves. This work was formerly done in the lathe, and when the reamer was so used, it did very satisfactory work; but in order to lessen the cost of production the drill press was tried. At first, the reamer



Leather Washer which fits between the Reamer Teeth and prevents Chattering.

chattered so that the drill press had to be abandoned; but this chattering was finally overcome by the use of a leather washer, such as here illustrated, under the reamer. The leather strips *A*, which are a little thicker than the depth of the teeth, are placed between the latter. When making the washer a block of hard wood was fastened to the drill press table with the grain vertical, and an impression made in the wood by running the reamer into the end. A piece of leather of suitable size was then soaked in warm water until it was perfectly pliable. At night, when the shop shut

down, the leather was laid over the impression in the wooden block and the reamer forced into it by the hand feed. The leather was left in this position over night, and in the morning it was dry, and formed perfectly to the tool. All that remained to be done was to cut spaces for the reamer teeth.

Geneva, N. Y. ROY B. DEMING.

UNIVERSAL CAMERA BRACKET.

In the February, 1908, issue of MACHINERY, the writer described a simple camera holder to be used when photographing tools or other objects laid on the floor. However, the writer has since then seen another camera bracket which is even better and which combines the features of being universal, rigid, and cheap. It is far superior to the ordinary ball and socket joint universal camera holder, where the camera is liable to fall over in any direction when the thumb nut is loosened.

Fig. 1. Universal Camera Bracket of Simple Design.

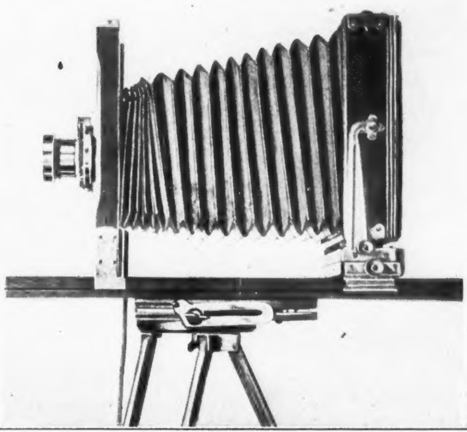


Fig. 2. Camera mounted in Horizontal Position in Bracket.

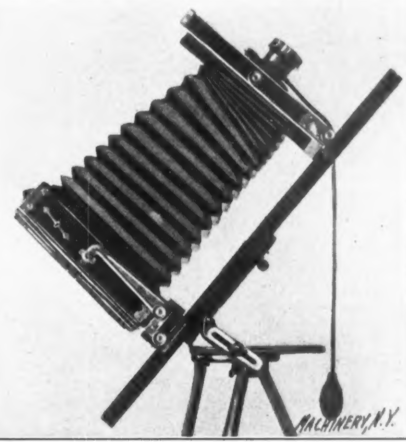


Fig. 3. Camera mounted in an Inclined Position.

The accompanying illustration, Fig. 1, shows very plainly the general construction of the bracket, and the illustrations,

Fig. 4. Camera held in Vertical Position on Bracket.

Figs. 2, 3, and 4, show the camera in different positions, mounted on the tripod. The detail dimensions given below are for brackets used with a 5 by 7 inch camera. The top and bottom boards, which are each made of three layers of wood glued together, are $5\frac{1}{4}$ inches wide, $7\frac{1}{2}$ inches long, and $\frac{3}{8}$ inch thick. The top of the tripod, on which the bracket is mounted, is 5 inches in diameter, and the boards were made $5\frac{1}{4}$ inches wide, in order to make the side clamping pieces clear the top of the tripod. The two boards were made by a trunk maker for 35 cents. The two hinges are common $1\frac{1}{4}$-inch brass hinges which will cost 5 cents. The two thumb nuts and the thumb screw required may be bought for another nickel. The adjusting slides are cut and filed out of 1/16-inch spring brass, the slot in them being $2\frac{3}{4}$ inches long, and just wide enough to admit a 3/16-inch bolt. This bolt is made like an ordinary stud bolt, except that it is provided with wood-screw threads on one end. The end provided with standard threads has a screw driver slot cut into it. A brass nut is set into the lower board, $2\frac{1}{2}$ inches from the edge on which the hinges are fastened. The regular tripod thumb screw is screwed into this nut. The thumb screw which fastens down the camera is set into the upper board $3\frac{1}{2}$ inches back from where the tripod thumb screw comes through the lower board. A hole, $1\frac{5}{8}$ inch in diameter, is cut into the lower board, for the head of the thumb screw in the upper board, so that two boards may be folded together. The object of placing the thumb screw holding the camera so far back, is to provide means for getting at both thumb screws at the same time, no matter what the position of the camera. A piece of cotton flannel cloth is glued to the top of the upper board to avoid scratching the camera base, and to prevent slipping. The bracket is easily carried fastened to the tripod, and provides the cheapest and most useful camera bracket the writer has ever seen. ETHAN VIALL.

Decatur, Ill.

SQUARES ON THE ENDS OF TAPS AND REAMERS.

It is to be regretted, in these days of standardization, that our tap manufacturers cannot all get into line regarding the sizes of the squares on the ends of taps. Owing to the bruised and twisted squares on the ends of taps in a shop I recently worked in I had to help in systematizing the whole matter of squares on the ends of taps and reamers. It was found that the taps as made by the makers did not have the same size squares; they were thus often very loose fits for our tap wrenches, so it was decided to ask six of the best-known tap manufacturers to submit the sizes of squares adopted by them for their taps, and from these details to determine a standard.

Table I shows the different makers' practice, which, as can be seen, varies very much, and as experience has shown that even these sizes are only used approximately, it was decided to adopt the standard as shown by the last column, to use solid tap wrenches with square holes of these standard sizes, and to grind down the squares of all taps in use to a few thousandths below these sizes. By comparing the last column with the other sizes, it will be found that it is now possible to buy taps from any of these six makers with the assurance that the square can be made to suit our standard tap wrenches. All new taps bought must, of course, be carefully examined regarding the squares, and, where necessary, be at once ground down to the standard.

While the above only discusses the question of squares, I should like also to say that there seems to be a difference of opinion among manufacturers as to the amount to leave on the diameter of new taps so as to ensure a reasonably long life and yet, at the same time, make them conform to standardized screw gages. For instance, one maker sends out his ¾-inch taps 0.0025 inch above nominal diameter, while another sends them 0.01 inch above. Why this difference? It cannot all be accounted for by distortion in hardening; it therefore raises the question of what are the practical limits. If 0.0025 inch is sufficient, then 0.01 is too much, and *vice versa.* This point, therefore, should receive some special consideration from tap manufacturers so that one set of limits might be adopted and adhered to by all manufacturers of taps.

TABLE I. SIZES OF SQUARES ON TAPS.

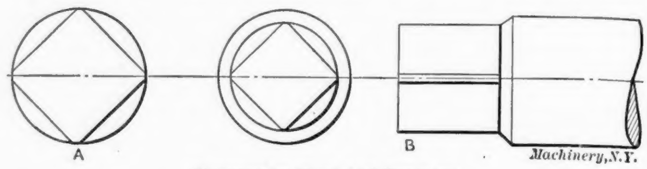
Diameter of Tap.	Maker No. 1.	Maker No. 2.	Maker No. 3.	Maker No. 4.	Maker No. 5.	Maker No. 6.	Adopted Squares.
1/8"	5/32"	7/64"	1/8"	0.145"	3/16"	5/32"	3/32"
5/32	5/32	9/64	1/8	0.145	3/16	5/32	1/8
3/16	5/32	5/32	1/8	1/8	3/16	5/32	1/8
7/32	5/32	11/64	3/16	11/64	3/16	5/32	5/32
1/4	3/16	3/16	3/16	13/64	3/16	3/16	3/16
5/16	3/16	1/4	7/32	1/4	1/4	13/64	3/16
3/8	7/32	1/4	7/32	7/32	1/4	15/64	7/32
7/16	1/4	9/32	1/4	7/32	1/4	7/32	7/32
1/2	5/16	5/16	1/4	17/64	9/32	5/16	1/4
9/16	11/32	11/32	5/16	5/16	5/16	11/32	5/16
5/8	3/8	13/32	11/32	11/32	3/8	25/64	11/32
3/4	7/16	15/32	7/16	27/64	7/16	15/32	13/32
7/8	9/16	9/16	1/2	1/2	9/16	35/64	1/2
1	5/8	21/32	19/32	9/16	5/8	5/8	9/16

The squares on the shanks of reamers are in the same unstandardized state. Table II gives sizes of squares adopted by two of the most prominent American makers of hand reamers. Each maker has a standard of his own, which is different from his neighbors', and is also different from that adopted by the tap manufacturers, so that it would be required to buy a great many wrenches to cover the requirements unless some such plan of standardization as outlined above is adopted. Of course, adjustable tap wrenches might be used, but solid tap wrenches are preferable if a number of taps and reamers are in daily use, because there are no parts to get out of order; they are, as a rule, lighter and are thus easier to handle, giving the operator more command over the tap or reamer; they are cheaper, and therefore a fuller equipment can be had with the same investment of capital; and a much closer working fit can be maintained between square and square hole, thus obviating the unsightly twisting off of the squares. "MECHANIKOS."

TABLE II. SQUARES OF HAND REAMERS.

Reamer Sizes.	Maker No. 1.	Maker No. 2.	Reamer Sizes.	Maker No. 1.	Maker No. 2.
1/2"	3/8"	3/8"	1 3/16"	11/16"	11/16"
9/16	3/8	3/8	1 1/4	7/8	7/8
5/8	7/16	3/8	1 5/16	15/16	7/8
11/16	15/32	3/8	1 3/8	15/16	7/8
3/4	15/32	9/16	1 7/16	15/16	7/8
13/16	17/32	9/16	1 1/2	15/16	1
7/8	9/16	9/16	1 5/8	1	1
15/16	5/8	9/16	1 3/4	1	1 1/4
1	5/8	11/16	1 7/8	1	1 1/4
1 1/16	11/16	11/16	2	1	1 3/8
1 1/8	5/8	11/16	2 1/4	1	1 3/8

[The question of uniformity in the size of squares on taps and reamers is certainly one that ought to receive proper attention. In the case of the squares on taps as indicated by the last column in Table I. it will be seen that when the square is made small enough to be below the size of that used by all the makers of taps, sharp corners are produced when the squares are ground down to this size. Square corners on a tap or reamer square are rather objectionable; not only does it make the tool unpleasant to handle, but the appearance and finish of the tool is greatly impaired. The proper square for any size of shank is to make the size of the square equal to ¾ of the diameter of the shank. This will leave small rounded portions at the corners of the square, as shown at *A*, in the accompanying engraving. In the case of hand reamers, however, the squares should not be milled directly on the shank as is the case with taps, because the shank on hand reamers is of nearly the same diameter as the reamer itself, and is supposed to be able to pass clear through a reamed hole. If the square is milled directly on the full diameter of the shank, burrs will be thrown up by the wrench, and these are liable to mar the reamed hole. The end of the shank of a reamer should therefore always be made as indicated in the engraving at *B*. The shank should be turned down a sufficient amount below its full diameter for the length of the square, and then a square equal to ¾ of the diameter of this turned-down portion should be used. Some makers do not turn down the end of the shank, but simply mill the square small enough so that the edges of the square come below the outside diameter of the shank, but this, of course, produces sharp corners, gives an unsightly appearance to the reamer, and makes it unpleasant to handle.—EDITOR.]



Squares on Taps and Reamers.

HOW MANY GASHES SHOULD A HOB HAVE?

In the article with the above title published in the engineering edition of the January, 1909, issue of MACHINERY, the author, after mentioning the well-known relation between the number of flutes in the hob and the number of threads in the worm, says, "this is one requirement, but there seem to be other factors that enter into the decision as well." He then proceeds to explain the relations existing between the number of teeth in the worm-wheel and the number of threads in the worm.

In a letter in the *American Machinist* for October 11, 1906, the writer uses the following language: "Another point learned in the work of Messrs. Brown & Sharpe, is that a hob will sometimes cut rough teeth if the number of teeth in the wheel is a multiple of the number of threads in the hob, even though the hob is fluted in accordance with what I have pointed out in this letter." I have written in regard to this matter, thinking you might like to call attention to the fact that the principle discovered was known in the Brown & Sharpe Works some little time ago.

The outlines of the wheel teeth can sometimes be cut somewhat more accurately and smoothly by shifting the thread of the hob into different tooth spaces, but I should not care to recommend this scheme as coming from the Brown & Sharpe Mfg. Co. OSCAR J. BEALE.

Providence, R. I.

A BEVEL GEAR PROBLEM.

In cases where a bevel gear drive with a shaft at an angle to the face of the frame, and also at an angle to the vertical center line of the machine, producing what might be called a double diagonal shaft, cannot be avoided, the following formulas and illustrations will be of great value in figuring the actual angle between the shafts, as well as the two angles to which the bearings for the double diagonal shaft must be bored.

Fig. 1 shows three views of the drive, and indicates clearly how it is arranged. Fig. 4 is a front view showing the angle x between the shafts in a vertical plane. Fig. 3 is the development of the plane AB, showing the actual length AB_1 between the apices of the bevel gears, and also the actual distance BB_1, to which the upper apex is offset from the lower, and the actual angle between the center lines of the upper gears.

Fig. 2 is a development of the oblique plan AB_1C on which the gear apices A and B_1 are located, showing the actual

length AB_1 between the apices, and the actual angle z between the center lines of the lower gears, for which these gears must be figured. Fig. 5 is a side view showing the shortest distance CB_1 between the center line of the lower shaft and the upper gear apex.

The angle x, the vertical height BC (Fig. 4), and the horizontal distance BB_1, are considered as given. From these we can easily get angle y.

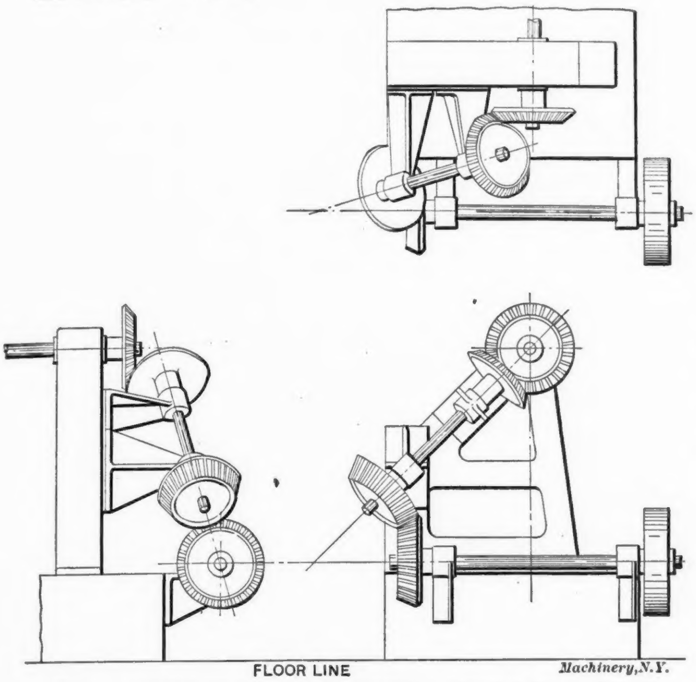


Fig. 1. Arrangement of Bevel Gearing with a "Double" Diagonal Shaft.

The formula for figuring the angle y is deduced as follows: In Fig. 4, let $BC = a$; and angle $= x$; then

$$AC = \frac{a}{\tan x}; \text{ and } AB = \frac{a}{\sin x}.$$

In Fig. 3, $AB = \dfrac{a}{\sin x}$; angle $= y$; then

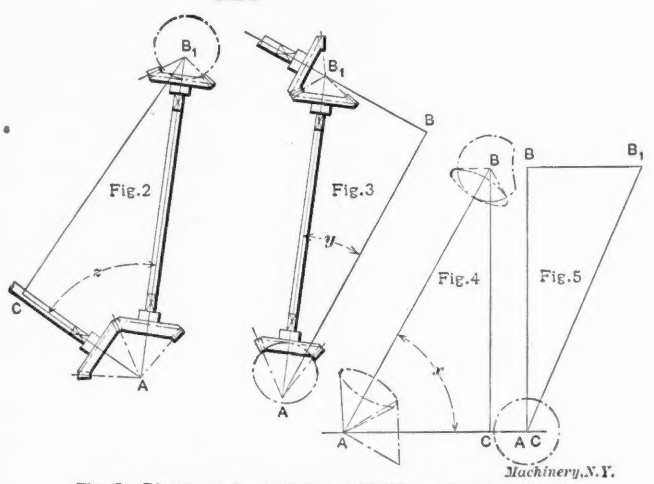


Fig. 2. Diagrams for Solution of Problem shown in Fig. 1.

$$AB_1 = \frac{\dfrac{a}{\sin x}}{\cos y} = \frac{a}{\sin x \cos y}.$$

In Fig. 2, $AC = \dfrac{a}{\tan x}$; $AB_1 = \dfrac{a}{\sin x \cos y}$; angle $= z$; then

$$\cos z = \frac{\dfrac{a}{\tan x}}{\dfrac{a}{\sin x \cos y}} = \frac{a}{\tan x} \times \frac{\sin x \cos y}{a} = \frac{\sin x \cos y}{\tan x};$$

But since $\tan x = \dfrac{\sin x}{\cos x}$

$$\cos z = \frac{\sin x \cos y}{\dfrac{\sin x}{\cos x}} = \cos y \cos x.$$

$$\cos z = \cos y \cos x. \quad (1)$$

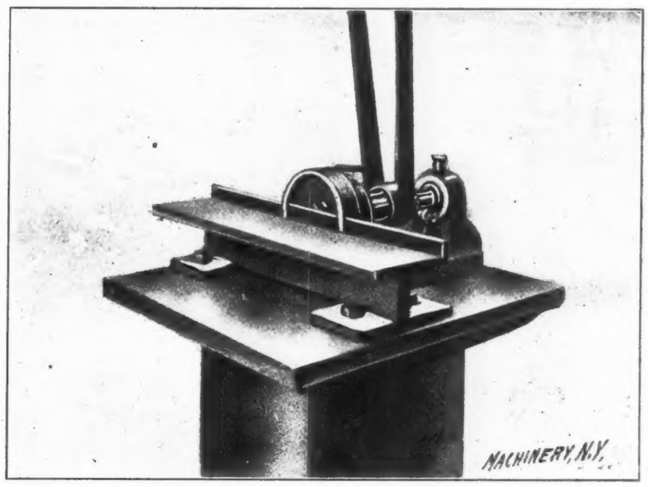
$$\cos x = \frac{\cos z}{\cos y} \quad (2)$$

$$\cos y = \frac{\cos z}{\cos x}. \quad (3)$$

Brooklyn, N. Y. EDW. PERSON.

SPECIAL GRINDER.

The half-tone engraving below shows a grinder on which work is done much in the same manner as on a buzz planer. A large number of drawn steel strips of various lengths are found to be slightly convex on the sides, the difference being about 0.001 inch in thickness for a width of ⅝ inch. It was required that these strips be of exactly the same thickness for the full length, and for the purpose of making them uniform the grinder illustrated was built. The table is provided with a rib, which is slotted in two places, and the



Special Grinder for Accurate Grinding.

cylindrical part of the cup wheel passes through these slots as shown. The table itself is set at a very slight angle to the plane of the face of the wheel, so that only one side of the wheel (that which is running in the downward direction) extends beyond the rib. This side of the wheel projects through the rib about 0.001 inch. By means of this device the operator is enabled to quickly remove the superfluous stock from the steel strips, and to do it accurately.

Middletown, N. Y. DONALD A. HAMPSON.

THE EXPERIENCE OF A CUSTOMER.

After reading your editorial entitled "The Experience of Purchasing Agents" I was led to compare the experience of the founding firm mentioned with the treatment handed me by a like firm which, by a queer circumstance, happens to make just such a device as mentioned in the editorial. In my case I was not the seller but an inquiring buyer, with ready cash to pay for what I wanted, out looking for someone to make an article at the best price. The matter I made inquiry about was not of much account, I acknowledge, but it was not the only work I was likely to have to offer such a concern. I went to this company and asked them to cast two sets of parts and to give me an estimate of their charge for finishing a lot of the pieces. The castings were to be ready in two days and at that time I was also to have the figures of their estimate. When the time came I got the castings, for which they charged just seventy-five per cent more than I could get them made for at another place, as I found out later. As for the estimate—well, the official that took my order was out of town and no one else seemed to know about it. "He will be back tomorrow," I was told, so to be decent I went again the next day, but he had not re-

turned. I was taken up to see the superintendent whom I found busy with another official painting a box. After waiting about three minutes I was finally approached by the superintendent, but he knew nothing of the estimate. In reply to a query about the cost of castings and how they came to charge so much for the ones they had made, he gave the arguments that one usually hears when a price is questioned. I wanted to laugh when he suggested that when I bought a watch I had to pay for something more than metal at so much per pound. The comparison between making a watch and a simple block of cast iron seemed just a bit bright.

Now what I am writing all this for is to draw attention to the point of view of the purchaser who goes out seeking the best place to spend his money, and what effect the manner in which he is received will have on his decision to leave an order. Surely he will not be likely to waste much time on a firm that does not endeavor to give him good service, and if he goes away with a feeling of disgust he isn't coming back very soon.

If firms have difficulty in selling their wares, and what firm does not, I would like to ask why it is that some neglect to make friends of purchasers who come inquiring about goods.

Somebody will say, perhaps, that the small jobs are not worth bothering with; but everything has been begun in a small way and who can tell what is not going to develop? As in the case previously referred to, the little job might be closely connected with something more important that would be worth getting—at least in these slack times. I have considerable work that I must send out, such as castings and machine work that I can not handle. Will this firm get the work? Hardly, but they would have had it, for they are the handiest for me to go to at present. They also make drill presses and bench lathes that I might need if my present tools gave out or I needed more. How much cheaper it is to make sure of the trade that comes inquiring than that which has to be sought; this seems to me to be a matter for consideration that seldom enters into the business plan of machinery concerns.

How often have I noticed, when going to a factory to inquire about tools or some other product, how patient one has to be to get waited on. Generally one goes into a door and lands up against a rail or a partition with a hole in it, and, after waiting awhile, a small boy asks you how you dare come in, and after you have told him that you only want to spend some money, he goes off and leaves you to sit down to wait. If you do not sit down you are quite likely to get tired of waiting and walk out to some other house. After the salesman finally gets to you he has to make you forget the time and trouble it has been to be able to tell him what your business is.

If the sales agents find that inducing a purchaser to buy something they want to sell is discouraging work, let them get busy and devise some new ways of handling the customer that is trying to spend his money. "A Buyer."

HARDENING TAPS.

Some time ago a certain jobbing shop contracted to produce 100 taps which, as expected, furnished no little trouble in the hardening, before a successful *modus operandi* was worked out. The contract specified a No. 10 tap, 7 inches long, with 4 inches of thread. Threading and fluting was a simple and inexpensive matter, the only extra outlay being for master dies for the screw machine and a special support to keep the taps from springing under the milling cut. Hardening, however presented life-size difficulties. Several of the usual ways were experimented with and discarded. The taps were heated in an open fire, a pot of lead, or a gas furnace, and quenched in oil or water, but the result was always the same—the taps were warped 1/16 inch and worse. A sample submitted to the customer was promptly and emphatically rejected. Then case-hardening was tried, and with an unlooked-for degree of success. The taps were heated in the gas furnace, rolled in a mixture of powdered prussiate of potash and flour, and quenched in water. They came out perfectly true and straight, and the temper was afterward drawn with a blow torch. A subsequent duplicate order (at an advanced price) was an assurance of the satisfaction they gave in service. Just why the taps warped in one case and not in the other, is not apparent, for, with the exception of the case-hardening application, the methods were identical.

Middletown, N. Y. Donald A. Hampson.

DRILL PRESS VISE WITH ADJUSTING JAW PLATES.

I noticed in the February number of Machinery an article on a drill press vise. Mr. A. J. DeLille, in describing the vise, which has several excellent features, devoted the major part of his description to one feature only, viz.: the jaws being under-cut and the jaw plates sliding down when the article to be held is gripped. The work is thus pressed firmly and uniformly down upon the surface of the vise.

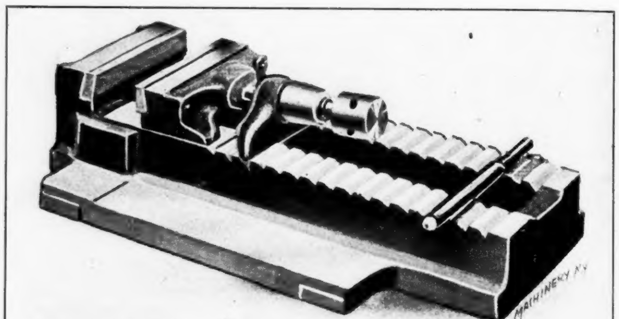


Fig. 1. Taylor's Standard Pattern Machine Vise, with Adjusting Jaw Plates.

It may interest Mr. DeLille to know that I am the inventor and patentee of this vise, and I take this opportunity of expressing my surprise that it has not come into wider use in the United States. I do not see why practically every machine vise should not be made with these sliding jaw plates. My patents expired some years ago, and there are six or seven British firms, in addition to myself, making this type of vise, and on the continent, especially in Germany, it is made by

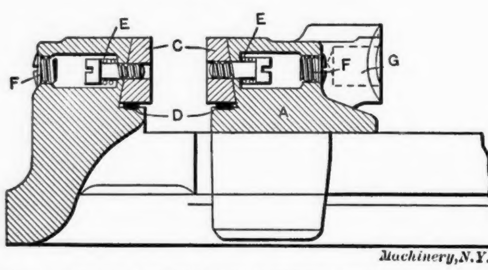


Fig. 2. Section through Vise, showing Construction of Jaws and Sliding Plates.

thousands. Yet none of the leading United States makers show it in their list of vises. I have failed to find any adequate reason for this vise not meeting equal popularity in America. Charles Taylor.

Birmingham, England.

[The following description is supplied by Mr. Taylor: Fig. 1 shows the Taylor standard pattern vise, and Fig. 2 is a section of part of the vise showing that the rear faces of the steel jaw plates C are inclined, thus causing them, when an article is gripped in the vise, to slide downward for a very short distance, carrying with them the article held, the pin holes in the jaws being slotted to allow of this motion. The jaw plates are held back against the jaw by screws and springs E. The jaw plates are raised again, when the article held is released, by simple springs, working in the recesses D, shown at the bottom of each plate. The small cap-screws F keep water and dirt from entering the pin holes. G is a piece of hardened steel fixed in the jaws to receive the pressure of the screw.—Editor.]

* * *

A rival of the Maxim muffler for firearms has been invented by Joseph C. Coulombe, a graduate of Norwich University, Northfield, Vt. The Coulombe invention differs from the Maxim silencer in that it is not an attachment to the end of the barrel, but forms part of the barrel itself.

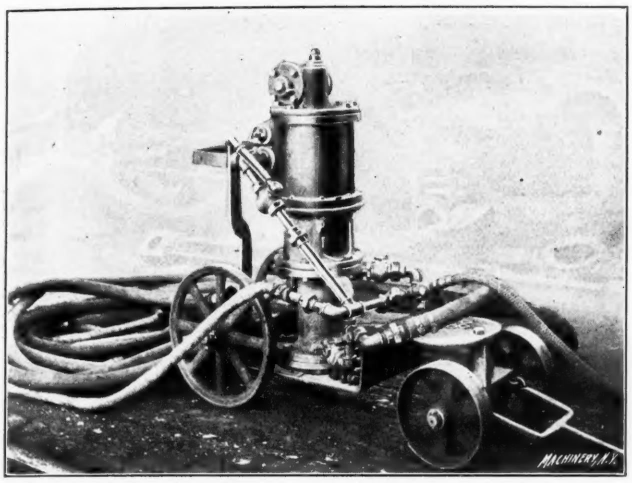
SHOP KINKS.

PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

A PORTABLE LOCOMOTIVE BOILER TESTER.

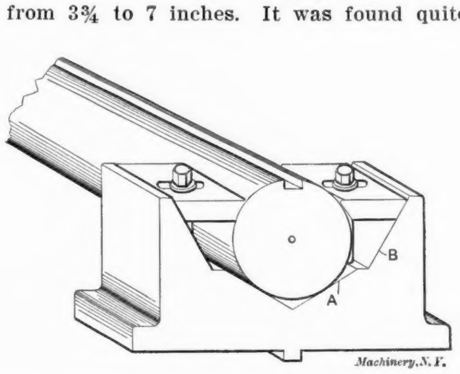
A very convenient apparatus for testing locomotive boilers is in use in the Fort Wayne shops of the Pennsylvania Railroad. The device consists of a powerful water pump operated by air, which is mounted on a truck as shown in the illustration. This machine, together with the necessary hose, is easily moved to wherever it is needed; the air hose is



then connected with the regular shop air supply and the water suction hose with the water supply. The discharge end of the water hose is coupled to the inlet valve on the boiler. The pump is then started and the cold water pressure run up to the desired point. After the test is over, the air and water hose are coiled around the pump cylinders and the machine is moved out of the way until it is again wanted. E. V.

ADJUSTABLE V-BLOCK.

Of the thousand and one appliances such as jigs, etc., that are in use in machine shops, there are but few that are applicable to more than the one purpose for which they were designed. In the shop in which I am employed, there is a pair of V-blocks used for the purpose of holding spindles that are to be splined their entire length and which vary in diameter from 3¾ to 7 inches. It was found quite difficult

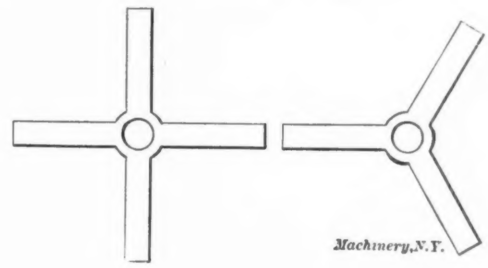


to hold these spindles in ordinary V-blocks or in a slot of the planer platen with ordinary clamps and bolts. The V-blocks shown herewith not only hold the work securely, but adapt themselves to spindles of different diameters. They are cast hollow to make them light. The angles of the sides *A* and *B* are 30 and 60 degrees, respectively. The clamps are slotted, as shown, to permit adjustment and are tightened against the work by two ¾-inch collar bolts. These blocks, which have a very powerful grip, are also useful for holding large impression rolls when slots to receive a steel blade are being cut in the rolls. They can also be used to advantage on the milling machine when doing work such as here illustrated. C. E. HALE.

Lockport, N. Y.

PARALLELS FOR VERTICAL BORING MILLS.

The parallels illustrated herewith, which are for use on the vertical boring mill, are almost invaluable for the chucking of pulleys, gear blanks, or anything that requires to be parallel with the face of the chuck. The parallel with four arms is intended to be used in conjunction with a four-jawed chuck,

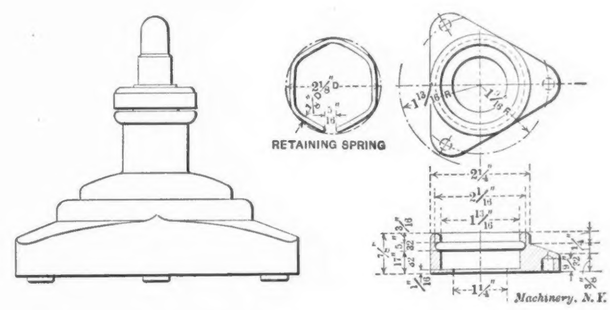


while the one with the three arms is for a three-jawed chuck. A cored hole should be provided in the center, as shown, which is somewhat larger than the holes being bored, to provide clearance for the boring tool. One of the most valuable features of a parallel of this type, is that it is impossible, when starting up the machine at high speed, for it to fly out and strike the operator. We have all our mills fitted with these parallels to accommodate the different sizes of work, and would dislike very much to have to do without them.

Franklin, Pa. B. M. WELLER.

HOLDER FOR THE INK BOTTLE.

One of the draftsman's troubles is that of keeping the ink bottle right side up, and although there have been many holders for this purpose, the one shown herewith will, I think, be of interest to fellow draftsmen. The bottle is held

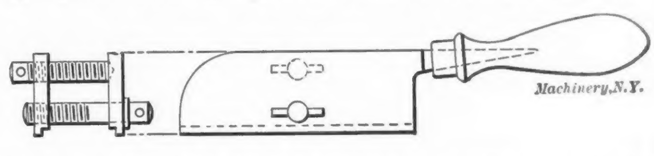


in place in the holder by a retaining spring which fits in the recess shown in the sectional view. This spring can be made in different shapes, if necessary, so as to receive almost any size or shape of bottle which will pass through the opening. When the spring is made to the dimensions given, it will be the right size when in place for holding a Higgins ink bottle. Common lead pencil rubbers are inserted into the three holes shown in the bottom of the holder for the purpose of preventing it from sliding when it is placed on a very slanting surface. C. S. BLANK.

Indianapolis, Ind.

OFFSET FILE HOLDER.

A simple form of offset file holder is shown in the engraving. The two sides are made of ¼-inch soft boiler steel, and between these the file is gripped. The lower screw shown, draws the jaws together, and the upper screw spreads them apart, thus forming a powerful clamp. The file is gripped



anywhere along its body, and as the teeth sink into the soft jaws, the handle is prevented from coming loose. This device may be used with more comfort when the handle is set at an angle as shown. L. J. SPARKS.

Chester, Pa.

HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give details and name and address. The latter are for our own convenience and will not be published.

TO OBTAIN THE SIDES OF A RECTANGULAR AREA IN THE SAME RATIO AS THE SIDES OF A GIVEN RECTANGLE.

B. W. C.—1. What is the rule for finding the dimensions of a rectangular area that shall have the same ratio between the sides as a given smaller rectangle? 2. What is the rule for finding the dimensions of a square prism whose sides shall be in the same proportion as a given smaller square prism?

A.—The rule is to divide the area of the required rectangle by the area of the given rectangle, and extract the square root of the quotient. The square root is the factor by which the dimensions of the given rectangle are to be multiplied to yield the dimensions of the required rectangle. For example, having given a rectangle 3 × 4 square feet, what are the dimensions of a rectangle having 192 square feet, with the sides of the same ratio? The area of the given rectangle is 3 × 4 = 12 square feet. 192 feet divided by 12 equals 16. The square root of 16 is 4. Multiplying both dimensions of the given rectangle by 4 yields 12 and 16. 12 × 16 = 192 square feet, the required rectangle. 2. Follow the same procedure for a solid as in the case of a rectangle, except that the cube root of the ratio of the given and required solids is found, and dimensions of the given solid are multiplied by the cube root, the result being the dimensions of the required solid. Example: A tank is 3 × 4 × 5 feet and it is desired to construct another tank containing 480 cubic feet with sides in the same ratio. What are the dimensions? Divide 480 by 60 the cubic contents of the given tank, extract the cube root of the quotient and the root is 2. Then the required tank dimensions will be 6 × 8 × 10 feet.

PROBLEM IN GRADUATING.

J. H.—The illustration shows a measuring tool which has a table in which two plugs *A* and *B* are located. The pin *a* is concentric with the plug *A* which is stationary. The plug *B* is free to turn, and pin *b* is 0.016 inch eccentric with it. The illustration is not drawn to scale in order that the problem may be made as clear as possible. The distance

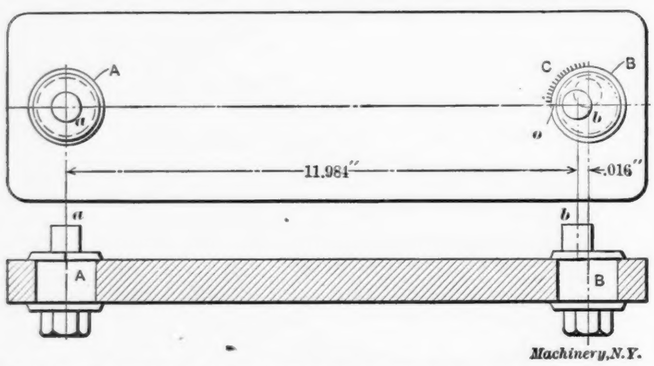


Fig. 1. Tool which is to be Graduated as shown at C, so that the Distance between the Pins a and b may be varied by Thousandths.

between the centers of the pins *a* and *b* is 11.984 inches, when *b* is in the position shown. I want to graduate the table, as shown at *C*, so as to increase the distance between the pins by thousandths of an inch. That is, so that when point *o* reaches the first graduation, the center of pin *b* will have advanced 0.001 of an inch, and so on up to 0.016 inch, when the center distance will be 12 inches.

A.—A graphic solution to the problem, which answers all practical requirements, is comparatively simple. It is unnecessary to take into account the slight increase due to the angularity, as the eccentric pin *b* is rotated toward the right-angle position, as the difference, because of the angularity, between the distance from the stationary to the eccentric pin when the latter is in the right-angle position, and the distance between these pins when they are in the same horizontal line, is only 0.00001 inch. That is to say, if the distance between the pins in the same horizontal line is 12 inches, the distance between them when the eccentric pin is removed 0.016 inch at right angles, as shown by the dotted lines, will only be 12.00001. Hence, this effect may be ignored entirely, and we may proceed as though the eccentric pin remained in the same horizontal line as the stationary pin and simply receded from it in a straight line as the movable bushing *B* is turned. To locate the graduating marks graphically, draw a quadrant as shown in Fig. 2, with a radius of, say 4 inches, the center being on the horizontal line *A—B*. Divide the radius into 16 equal divisions. Each one of these divisions will correspond to a movement of 0.001 of an inch in the ratio of 250 to 1. Then, from each of these division points erect perpendiculars cutting the circumference of the quadrant at 1, 2, 3, 4, 5, etc., and from the points of intersection draw radial lines to the center *C*. These lines subtend the angles to which the graduating marks on the table should be laid out. These angles can also be obtained directly without the trouble of laying out, by referring to a table of sines and cosines, or better to a table of versed-sines. A versed-sine of an angle is the difference between the

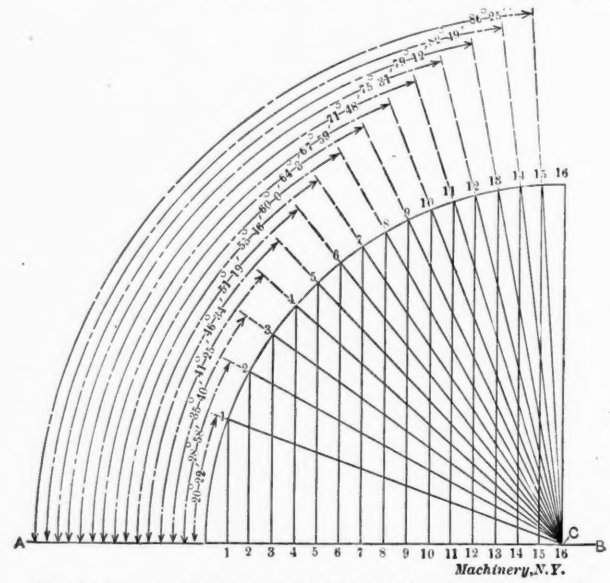


Fig. 2. Graphical Method of obtaining the Angular Positions of the Graduation Marks.

cosine and 1. Inasmuch as all tables of natural trigonometrical functions are for a radius of 1 and the eccentric bushing is to move on a radius of 0.016, it will be necessary to multiply the respective departures of 0.001, 0.002, 0.003 inch, etc., by 62.5 (which is obtained by dividing 1 by the radius 0.016) to make them agree with the versed-sines given in the table. Thus we find that the first departure from the circumference, indicated as 1 in the accompanying diagram, Fig. 2, multiplied by 62.5 equals 0.0625 which is the versed-sine of 20 degrees and 22 minutes, and 0.002 multiplied by 62.5 equals 0.1250, the versed-sine of 28 degrees, 58 minutes. In the same way we find the versed-sines for the sixteen angles as follows:

.0625 = 20 degrees, 22′	.5625 = 64 degrees, 3′
.1250 = 28 degrees, 58′	.6250 = 67 degrees, 59′
.1875 = 35 degrees, 40′	.6875 = 71 degrees, 48′
.2500 = 41 degrees, 25′	.7500 = 75 degrees, 31′
.3125 = 46 degrees, 34′	.8125 = 79 degrees, 12′
.3750 = 51 degrees, 19′	.8750 = 82 degrees, 49′
.4375 = 55 degrees, 46′	.9375 = 86 degrees, 25′
.5000 = 60 degrees, 0′	1.0000 = 90 degrees, 0′

Most handbooks do not include tables of versed-sines, and if a table is not available, first subtract the result obtained by multiplying 0.001 by 62.5 from 1, the result being 0.9375, which is the cosine of 20 degrees and 22 minutes. Proceed in the same way for all the others, first multiplying the departure by 62.5 and substracting the result from 1 to get the natural cosine of the angle.

* * *

The operating cost of the Brooklyn Bridge is found to be as high as $360,000 a year, according to an investigation made by the Comptroller of New York City. This figure is the average of ten years' maintenance and operating costs, beginning with 1898. In 1907 the cost slightly exceeded $400,000. The city's revenue from the bridge has exceeded $400,000 per year during the same period, and has always been larger than the cost until 1907, when there was a deficit of $3,250.

New York, April 1, 1909.

Dear Sir:-

Not long ago a well known firm of machine tool builders, of whom we made some enquiries regarding their apprenticeship system, wrote us that they had discontinued employing apprentices, and now employ, instead, laboring men twenty to thirty-five years of age, under a three year contract which calls for continuous service on one line of work.* These manufacturers do not lack public spirit by any means; they were forced into this common practice† by competition, as many other concerns are; but it is time for us all to consider the effect on our mechanical future of the almost total lack of opportunity to learn machine shop practice in our works. Unless such conditions materially change, we are not likely to be the leading mechanical nation in the world twenty-five years from now.

As you know, thousands of our mechanics, young and old, lack sufficient elementary education to read a mechanical journal intelligently or profitably; and for them such papers do not exist. They should be educated to a point where the mechanical journal begins; yet the general tendency of shop work is to deprive them of whatever ambition to acquire an education they may possess.

We acknowledge that the tastes and inclinations of perhaps three-quarters of the young men in our shops are away from, rather than towards, educational work; but let us consider the remaining fourth, among whom must be found the designers, superintendents and mechanics of the next generation. This aspect of the proposition should appeal to everyone connected with the manufacture of machinery; and we need not point out the results of even a modicum of education--the awakening of a man's ambition, the quickening of interest in his work, the increased chance of an appeal to his reason on questions between employer and employee.

MACHINERY began fifteen years ago as a shop paper--an educator-- but the character of its reading matter gradually and necessarily improved as its readers advanced in age and knowledge. For eight years we have kept a careful record of their occupations, and a majority now occupy positions of responsibility. There is now no publication which contains matter of sufficiently elementary

*The text of the letter referred to will be found in an editorial, "The Apprenticeship Problem" on page 609 Engineering Edition.
†Common with the exception of the three-year contract provision.

character to supply the educational requirements of the shop man. The naked truth is that such a publication would not pay, because shop men are not buyers to any extent; advertisers therefore do not care to reach them, and it is the advertiser and not the reader from whom three-fourths of the income is derived.

Considerations for the future have appealed to a number of public spirited manufacturers, and have added impetus to the movement for training apprentices; but in thousands of shops it is impracticable to institute such a system, and out of the 600,000 workmen of all kinds in the machinery industry a small fraction only is systematically reached through that or any other educational method.

To supply this need--this great need--and not primarily as a money-making proposition, MACHINERY began in January, 1908, a system of self-education in mathematics and mechanics, planned to cover the entire field of mechanical practice, which should be available by every mechanic without regard to his means, and which he could pursue in connection with his work. The development of this system has been gradual and the cost considerable; but the results have been satisfactory and the future of the work looks bright, although we are only at THE BEGINNING. During 1908 we invested in this undertaking about $16,000, a portion of which has come back; and in 1909 we plan to expend about $24,000. We regard this work as of such far-reaching importance that we are quite willing to invest therein the major part of MACHINERY'S earnings for some years to come--say a hundred thousand dollars--and we believe this investment will prove a profitable one, both for the machinery industry and for ourselves.

But of equal importance with the educational work, and fully as necessary to results, is the cultivation of sentiment in its favor among manufacturers; and for that reason we are sending you this letter. If your position is one of authority, you can help us materially by encouraging the men in your employ to study systematically, and by rewarding them for improvement; if it is a subordinate one, you can help the movement by your influence and by a good word whenever you have an opportunity to speak it.

Will you do this?

Very truly yours,

THE INDUSTRIAL PRESS.

Alex Luchars

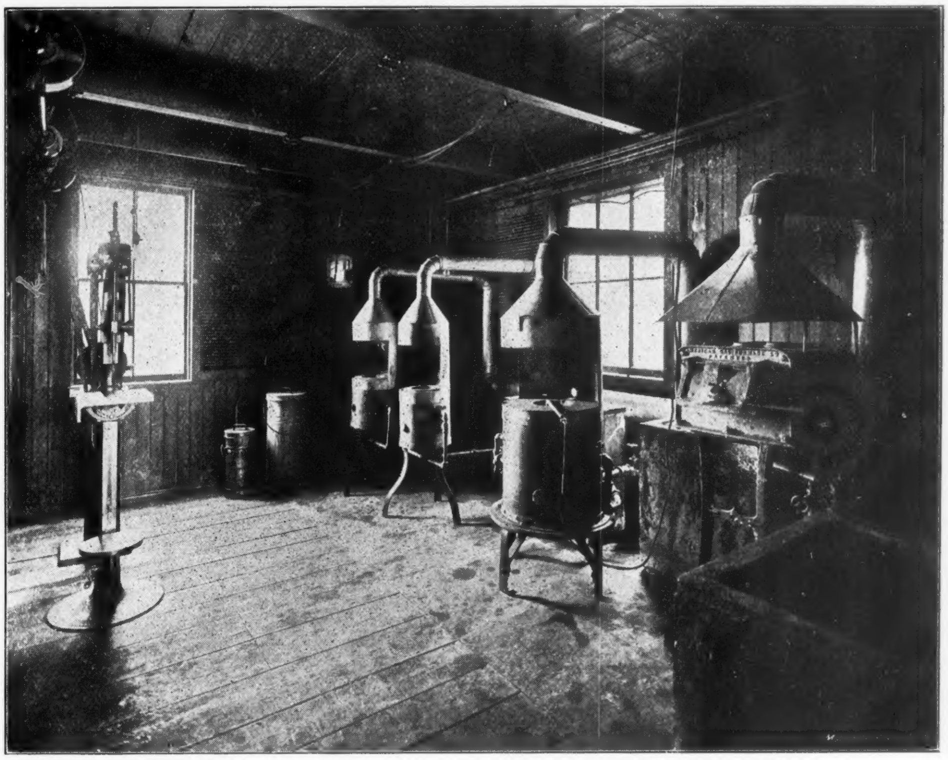
President.

L/H

THE HEAT TREATMENT OF STEEL.

From time immemorial when iron in its most crude form was introduced into the manufacturing and commercial field, it has been a well-known and accepted fact that heat with its varying degrees of intensity has a direct action on both the physical and chemical properties of the metal when the iron is submitted to its action; and, as a direct result, the entire structure of the iron is altered, and by altering or changing the method of application of the heat treatment, any desired structure of the metal, either steel or cast iron, may be obtained. In spite of the fact that the truth of the above exposition was generally acknowledged, very little, if any, use was made of it; but as science developed, competition grew keener and keener, and the general cry in the manufacturing world became "reduced cost and greater output." To balance the effect of increased power and consequently larger machines, the working strength of the cutting tool, together with the working stress of the machine members, had to be greatly increased, and, during the past decade, the heat treatment has done more than its share in the work of accomplishing the desired results. Therefore, the Worcester Polytechnic Institute, following its old and well-established custom of being the pioneer in all branches of scientific investigation, has, during the past year, through its department of Mechanical Engineering, designed, constructed and equipped a modern plant devoted exclusively to the heat treatment of steel; the more important operations to be performed are hardening, annealing, tempering and case-hardening. From the very general description given in the following paragraphs of the equipment and facilities of this plant, it will be easily seen that all grades of steel from the 15 point carbon steel to the high-speed, alloy, air- and water-hardening steel may be conveniently and efficiently handled and treated.

The plant consists of a room of spacious size, in the design of which the comfort of the operator was well provided for. The temperature and ventilation of the room is controlled both by a fan and large windows which admit subdued natural light but exclude the direct sunlight, which is so undesirable in this kind of work. These windows are provided with shutters so that the natural light may be excluded; artificial illumination is obtained by means of incandescent electric bulbs. The room appears to a visitor, at first, somewhat like a dungeon, as the walls and ceiling are painted a "dead black," which color prevents any reflection of the various colored rays when the operator is experimenting on "color work." After this first impression has left the visitor and he has become accustomed to the light, the next thing that catches his eye is the row of various shaped furnaces placed symmetrically on the right side of the room. For convenience and simplicity, we will designate these furnaces (from right to left in the engraving) by the letters *A*, *B*, *C* and *D*. Furnace *A* (constructed by the American Gas Furnace Co.) is built on the principle of the muffle furnace, is of the box type, and will readily heat a block of steel 8 x 4 x 14 inches. A temperature of from 2,000 to 2,100 degrees F may readily be obtained by means of this heater, which is used to heat such work as requires an even heat and which would be destroyed by oxidation and the decarbonizing action of the air; reamers, mandrels, taps and drills in their finished state are good examples of this type of work. Furnace *B*, known as the "barium chloride heater," is circular in form and lined with fire-brick, and the chloride solution is heated in a crucible built of fire-resisting material. This furnace is of sufficient size to accommodate all ordinary tools, and is employed to heat such grades of steel as require a rather high temperature, as high speed steels, and which, at the same time, must be well protected in heating. This form of heat treatment is well adapted to those types and forms of tools which tend to heat unevenly, thus producing an unbalanced distribution of the shrinkage strains with the accompanying cracks. Furnace *C* is of the same general design as furnace *B*, with the exception that this heater is made use of in connection with the lead bath. As the lead melts at a comparatively low temperature, this furnace is used when a lower temperature than that obtained with the chloride solution is desired; for example, when heating carbon alloy steel. Furnace *D* is devoted to an entirely different operation, namely, oil tempering. Either linseed or machine oil is used in this heater, which is brought into action when the desired range of temperature is between the limits of 300 and 630 degrees F. The fuel used in all of these furnaces is the ordinary city gas, due to its convenience and ready accessibility, but oil fuel could be employed if so desired by the operator. As will be seen from the engraving, all the furnaces are provided with hoods of convenient form connected with an exhaust line, so that all poisonous fumes and gases such as lead, cyanide, barium chloride, etc., may be eliminated from the atmosphere of the room. At various and convenient positions about the plant are to be found rectangular tanks of convenient size, containing water and brine of varying densities. All the other baths, as for example, the various grades of oil and other cooling baths, are kept in covered cylindrical galvanized iron tanks. In order to properly care for and treat the air-hardening steels, an air jet is provided with a pressure of about 2 pounds.



Plant for the Heat Treatment of Steel, in the Worcester Polytechnic Institute.

The one feature which removes this plant from the class of the ordinary manufacturing establishment and places it in the ranks of those of scientific research and investigation, is its complete set of measuring instruments, including the Bristol and Le Chatelier pyrometers and thermometers covering a range of temperature between the limits of 0 and 2,960 degrees F. On one of the walls of the room is to be found the Bristol pyrometer, which is of the thermo-electric type, and consists of a permanent magnet moving coil type of galvanometer. The scale is graduated to read direct in degrees. Leads from the instrument extend over the entire room, so that it is a matter of a few seconds only to connect with the thermo-couple and obtain any desired temperature. If any question as to the accuracy of the instrument, or the action

of gravity on its oscillating parts is advanced, a Le Chatelier pyrometer, operating on the same principle but having a vertical support, may be brought into action and the first readings verified.

In order to facilitate the preparation of test specimens and other work, a Washburn drill and also a grinder are provided and placed on the opposite side of the room. The work in this new plant is not confined to experimental work alone, because the range of equipment provides all the requisites necessary for performing outside commercial work for those who have not the facilities to properly treat their own tools. This heat treatment room offers excellent opportunities for those taking the mechanical engineering course to become thoroughly conversant with the most approved and up-to-date methods of heat treating steel, and with this in mind, the attention of the student is frequently called to both the scientific and also the economic features of this work, which, during the senior year, has its position in the curriculum of the school.

* * *

IMPROVED METHOD OF CUTTING SCREWS.

An interesting method for the manufacture of power, lead-and feed-screws of all dimensions has been developed by the Screw Cutting Co. of America, 150 Berkley St., Wayne Junction, Philadelphia, Pa. The principle of the method employed by this company for cutting screws is conducive to a high degree of accuracy, and makes it possible to absolutely duplicate the lead-screw used in cutting the thread. The method is, briefly, as follows: A hollow lead-screw is employed, on one end of which a chuck is mounted; this chuck clamps the blank stock on which the thread is to be cut, the stock passing through the hole in the lead-screw; thus the lead-screw, the chuck, and the work on which the thread is to be cut, revolve together. The lead-screw passes through a stationary nut and thus feeds forward when revolving. The thread is cut by a milling cutter mounted in a stationary head provided with an arrangement permitting the cutter to be swiveled to

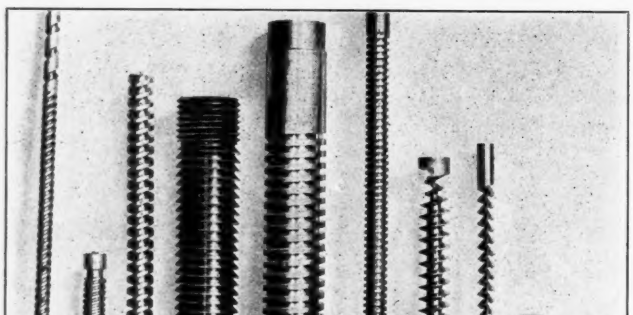


Fig. 1. Examples of Screws cut by the Method Developed by the Screw Cutting Co. of America.

the angle of the thread. The fact that the cutter head is stationary and that the work is attached directly to the lead-screw, makes it possible to exactly duplicate the thread on the lead-screw, there being practically no chance for lost motion of any kind. The lead-screw being comparatively short can be made with great accuracy, but its length in no way limits the length of the thread to be cut, as an arrangement is provided by means of which the lead-screw with its carriage can be returned to its original starting position at regular intervals. The blank stock is guided in bushings so as to run concentric, and the overhanging portions outside of the machine are supported by roller bushings, thus preventing any bending or springing action due to the weight of the over-hanging part. By the employment of the means referred to, it is possible to cut screws of any length for which blanks can be provided. The accompanying illustrations show some interesting examples of work carried out on the machines of the company. One interesting job lately completed was a 5/16-inch diameter screw threaded for a length of 18 feet, and on the same machine threads down to 1/16 inch in diameter have been cut. The highest capacity of the present machines is 12 inches diameter.

The upper view in Fig. 2 shows an interesting test applied to some of the screws cut by this method, indicating the truth of the lead of the screw. One-half of the screw is milled away in each of the two parts shown, and the two halves are put together as indicated, the thread of the one half matching exactly the thread of the other half. The supreme test of the truth of the lead is that the halves may be reversed, end for end, and put together, and still the same relation remains. If the lead were not correct, or if the shape of the thread were not uniform or the screw not exactly straight, it would not be possible to show so satisfactory a result when testing

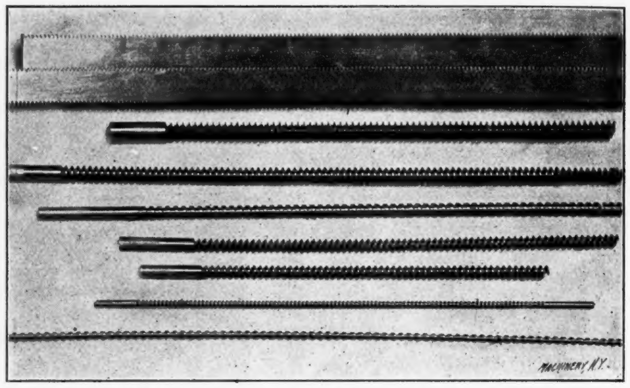


Fig. 2. Method of Testing Accuracy of Pitch of Thread, and Examples of Threaded Work of Small Diameter.

the screws in this manner. As the manufacture of accurate screws is one of the most difficult problems known, this method of producing screws is extremely interesting, and the production of screws with unlimited length of thread is a new departure in screw manufacture which undoubtedly will interest many mechanics.

The Screw Cutting Company of America devotes itself exclusively to the making of screws, but the machines on which the screws are manufactured are not made for the market. The company is at the present time building a larger factory in order to meet the increased demands for its product. The heavier machines will be placed on the concrete ground floor so as to eliminate vibrations that tend to impair the character of the product.

* * *

PROFIT IN TECHNICAL BOOK-MAKING.

Fiction is far from being the only big money making department of book publishing. Indeed, it is perhaps the most risky, because its public is the most fickle. On the other hand, no public is so faithful as that of technical publications, like law books and mechanical handbooks. More than one firm that very few people outside of technical circles ever heard of clears more than $1,000,000 profit every year out of just such publications, and most of the profit in each case goes into the pocket of one man. Take a volume like Kent's "Mechanical Engineer's Pocket Book," largely composed of tables and data. It was first published in 1895 and has been revised from time to time so as to keep it up to date. It has now sold a total of 60,000 copies, though it is an expensive book. Its author has made $5,000 yearly from its sale ever since it was published. Still another similar publication constitutes a family estate. This is Trautwine's "Civil Engineers' Pocket Book." It was written in 1882 by John C. Trautwine; its first revision was made by John C. Trautwine, Jr., and its third revision by John C. Trautwine, 3rd. It is strictly a family affair. It is a $5 book and its total issue to date is 94,000 copies. From its sale the Trautwine family has been in continuous receipt of an income of something like $6,500 yearly. Yet it is probable that not one person in a thousand who reads these words ever heard of the Trautwines.—*New York Sun.*

NEW MACHINERY AND TOOLS.

A MONTHLY RECORD OF APPLIANCES FOR THE MACHINE SHOP.

HOEFER MFG. CO.'S VALVE INSERTING MACHINE.

Machines for making pipe connections with water mains under pressure have been in use for a great many years and it would be difficult to get along without them. They are a part of the equipment of every water works plant and of every large manufacturing establishment. Their use per-

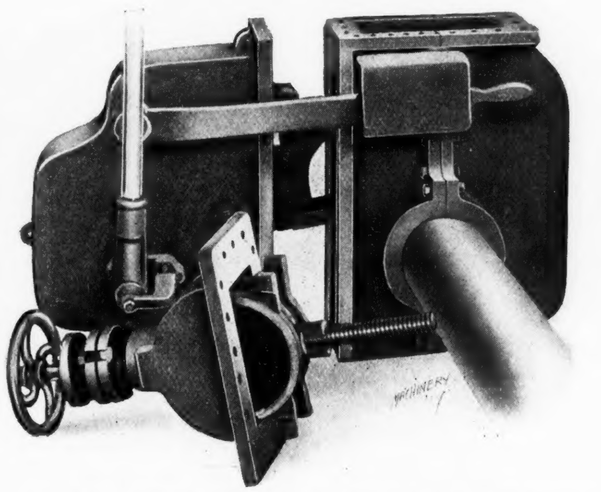


Fig. 1. A Device for Inserting a Stop Valve in a Pipe under Pressure.

mits making extensions to the piping system without the annoyance and danger involved in shutting off the main on which the work is to be done. But while this operation is common enough, so far as we know no one has up to this time attempted to insert a stop valve in a main without reducing the pressure or interfering with the flow. This feat is now easily performed by the aid of the ingenious valve insert-

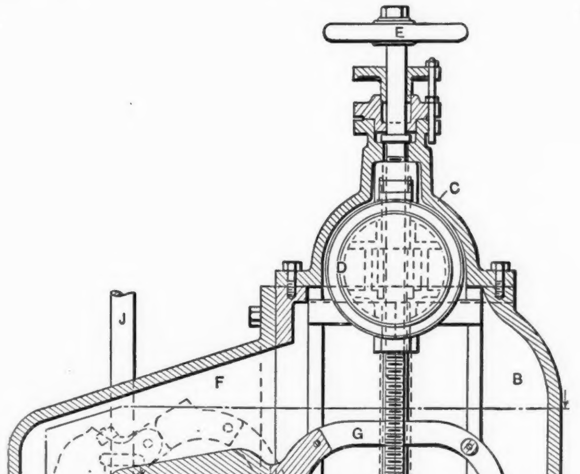


Fig. 2. The Mechanism of the Valve Inserting Machine.

ing machine, shown herewith, made by the Hoefer Mfg. Co., of Freeport, Ill. This device was suggested by a water works superintendent, who felt the need of replacing old and worn out valves in his water system and of inserting new ones as well. The device is simple and ingenious, and its action will be readily understood from the following description and illustrations.

Description of the Machine.

Figs. 1 and 2 show external and sectional views respectively. The casing of the machine is made in two halves, *A* and *B*, which are clamped around the pipe and permanently secured there. The joint between the two halves is made fluid tight by means of the bolts and faced joints shown. The semi-cylindrical flanges which embrace the pipe are calked against the pressure by the usual lead joint. To the rectangular opening at the top of the casing is clamped the valve dome *C*, which contains a valve stem and valve of the double expansion seat, gate variety, made by the Ludlow Valve Co., Troy, N. Y. The two circular valve plates *D* are forced against corresponding faced seats in the valve casing surrounding the pipe.

The pipe cutting mechanism is carried by casing *F*, which is clamped to the permanent valve casing at the left. This member carries a double hack-saw frame *G*, provided with two blades *H* and rocked by handle *J* which extends outside of the casing where it can be operated by the workman. The

Fig. 3. Sawing Arrangement Clamped in Place, ready to begin Cut.

hack-saw is obviously a suitable tool to use in cutting the pipe owing to its cheapness, the convenience of replacing worn blades, their ease of operation on account of the narrowness of the cut, and the familiarity of the workman with its use. These characteristics have brought the hack-saw into very extensive use for cutting off metal bars and pipes of all kinds.

The double hack-saw frame *G* carries the two saws *H*, spaced apart about $\frac{3}{8}$ inch narrower than the distance between the valve seats *K* in the valve casings. This permits the pipes to extend beyond these seats approximately $\frac{1}{8}$ inch when the middle section has been cut out. The cutting is effected by rocking handle *J*, thereby operating rock shaft *L*, which passes through a water-tight stuffing box into casing *F*. Here the crank *M* transmits the reciprocating movement to connecting rod *N* and then to hack-saw frame *G* with its two saws *H*. With the original construction shown in Fig. 2, the feed of the saw was dependent on the weight of the heavy connecting rod *N*. In the later design shown in Figs. 1, 3, and 4, the feed is effected by a weight mounted adjustably on the horizontal arm shown, which is connected to a second rock shaft passing through the casing and carrying an arm with a roller, which bears on top of the hack-saw frame as it is reciprocated back and forth. By adjusting the weight to different positions on the outside lever, the pressure of the

roller on the saw and the consequent rate of downward feed is altered as desired by the workman.

Use of the Device.

The operation of inserting a stop valve is as follows: After clamping casings *A* and *B* to the pipe and calking them to a tight fit by the means described, casing *F* with saw frame *G* and two sharp saws *H* is clamped into place, with the saws resting on top of the pipe. The workman now rocks the vertical handle *J* back and forth and the two saws begin to cut into the pipe. It is not necessary to fasten dome *C* in place with the valve disks and spindle, until the cut has been properly started, with the saws equally spaced. When this has been done, the dome must be permanently fastened into place, as shown in Fig. 3, before the saws have cut through into the interior of the pipe. The cutting is then continued with the feed weight adjusted properly to suit the conditions, until the section has been cut entirely out of the pipe. By tipping handle *J* back to a horizontal position, the saw will draw the severed section of the pipe back into casing *F*, as shown by the dotted lines in Fig. 2. Then by turning hand-wheel *E*, valve *D* is screwed down into place. This valve is of the type in which the two faces are spread apart to a bearing on flat parallel seats. It is thus possible for them to pass between the sawed edges of the pipe and expand over these onto the valve seats *K* in casings *A* and *B*. When the valve has been thus closed, casing *F* may be removed, as shown in Fig. 4, bringing with it the saws and the separated portion of the pipe. The rectangular opening thus left in casing *A* is closed by a cover plate as seen in Fig. 5, which shows the completed form of stop valve.

Fig. 4. Removing the Sawing Mechanism and the Severed Section of Pipe.

Of course, the casing fills with water the minute the saws cut through into the interior of the pipe. To keep this water out of the trench or floors where the workmen are at work, a drain cock is provided which permits the water to be run off into a pail before removing casing *F*. It will be observed that the flow through the pipe is interrupted only for the very few minutes that *F* is being removed and the cover-plate substituted.

The advantages of this device will be readily recognized. It is a comparatively inexpensive machine and can be operated by any competent foreman. It avoids the shutting off of water from customers or from fire hydrants in the case of an unexpected demand for water. It makes possible the installing of new hydrants or the replacing of old pipes with new hydrants having steamer nozzles. Its simplicity, reliability and ease of operation for these uses should make the machine particularly adapted to water works service. The same considerations make the device useful for industrial purposes as well. Not only is it useful for the installation of valves, but it can be employed in every-day shop work for cutting pipe, in which case one saw blade may be removed and special pipe holders attached to the machine.

HART'S "BUCKEYE" RATCHET-DRIVEN DIE-STOCK.

An extended description of the design and operation of the "Buckeye" die-stock, manufactured by the Hart Mfg. Co., 10 Wood St., Cleveland, Ohio, was given in the April, 1908, issue of MACHINERY; a gear-driven, large size die-stock of the same make was described in the January, 1909, issue. As will be remembered from these previous descriptions, the principal feature of the construction of the "Buckeye" die-stock is that the chasers which cut the taper thread on the pipe, and which while not as wide as the length of the thread, will still cut a full length thread of correct taper by means of a mechanism which permits the chasers to recede from the work as they progress along the pipe. Another feature of the die is the provision for automatically releasing the chasers when the full length of thread has been cut. A wide range of sizes may be cut with the same chasers by simply loosening a screw and setting a stop to the required graduation.

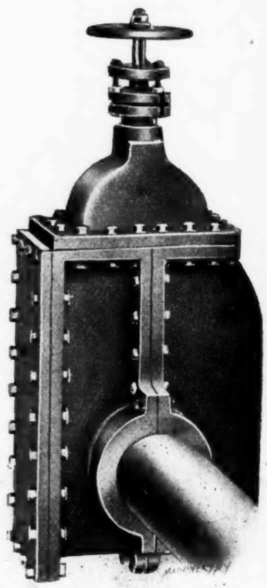
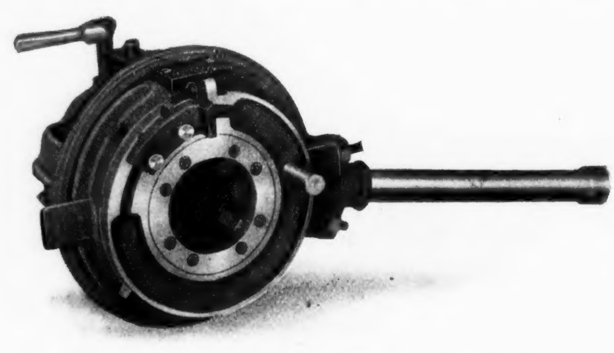


Fig. 5. Cover Plate Clamped in Place, and Valve Ready for Use.

The Hart Mfg. Co. has now brought out a "Buckeye" die-stock provided with a ratchet drive as illustrated in the accompanying engraving. The ratchet is enclosed by a ring provided with a projection into which the handle and two latches are fitted. The latches are so spaced that but one will be in engagement with the ratchet at a time, but the use of the two latches minimizes the amount of lost motion. They can be swiveled around so that the die can be used for cutting either right-hand or left-hand threads. The die-stock provided with this driving arrangement is intended for cutting pipe from one-half inch up to two inches in diameter. It is of especial advantage when it is required to thread pipe in close quarters, as it is not necessary to have more than five inches clear radius around the pipe, and, of course, space enough for working the ratchet handle. All other features of the die-stock are the same as those described in the April, 1908, issue of MACHINERY, mentioned above, where an extended illustrated description was given of the die-stock and the mechanical devices by means of which it is operated.



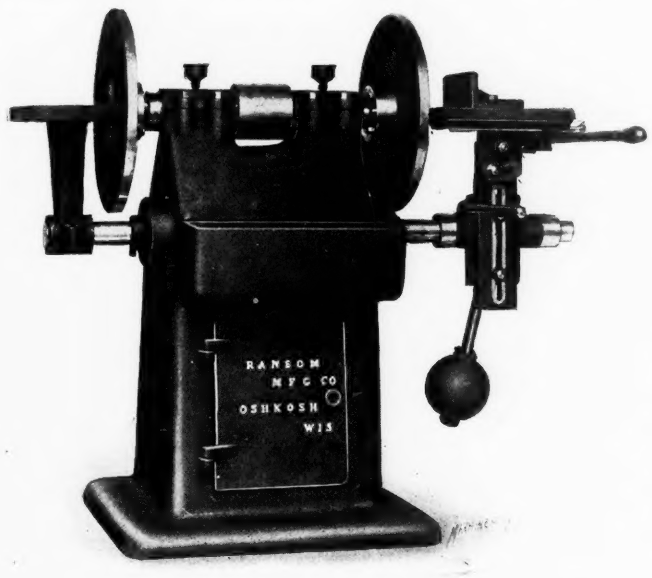
Ratchet Die-stock for Threading Pipe in Close Quarters.

RANSOM 18-INCH LEVER-FEED DISK GRINDER.

The Ransom Mfg. Co., Oshkosh, Wis., has placed on the market a disk grinder of new design shown herewith. The principal improvements relate to the thrust collars on the

arbor, oiling provisions for the counter-shaft and the use of steel disks in place of cast iron as commonly employed.

The spindle is made of high carbon steel, turned and ground, supported in babbitt lined bearings. The thrust collars have nine square inches of surface, and are made of hardened steel. The disks are also made of steel, and are turned true to within one-thousandth inch on their faces. They are fastened to the collars on the arbor with bolts and nuts, instead of by beveled head screws. These disks are



Improved Design of Ransom Disk Grinder.

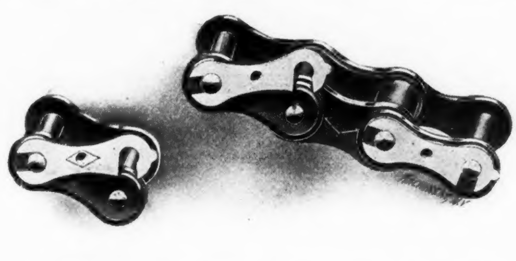
provided with or without grooves, as desired, though it is the builders' belief that better work is obtained with the plain-faced disks.

The counter-shaft has self-oiling hangers and a ground shaft. The loose pulley has an improved self-oiling bushing fastened to the shaft, drilled full of holes to retain a sufficient supply of oil to last several weeks. This insures lubrication of the loose pulley while the machine is standing still.

With the equipment shown in the engraving, a fixed table is provided at the left having a surface of 6 by 18 inches, square with the face of the disk. The oscillating table at the right has a surface of 7 by 12 inches, provided with two T-slots. The usual adjustments and movements are provided. The disks are 18 inches in diameter by ¾ inch thick. The bearings are 7 inches in diameter by 12 inches long. The counter-shaft, which should make 500 revolutions per minute, has tight and loose pulleys 10 inches in diameter.

DIAMOND DETACHABLE LINK TRANSMISSION CHAIN.

The Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind., has recently developed the detachable link form of chain shown herewith. It is designed to meet the objection urged at times against the chain drive, on the score that it



A Chain Separable at Any Point without the use of Tools.

cannot be conveniently altered in length, and that individual links and blocks cannot be quickly replaced when broken. These difficulties are here obviated by making every link detachable without the use of special tools.

The construction is evident from the engraving. The thin strip steel lock on top of each outside link slips into a groove around a rivet at one end, and, turning about that rivet as a center, enters a similar groove in the other rivet. This thin metal strip is locked in position by being slightly warped inward, and by having at its center a slight projection which snaps into a corresponding depression in the side bar. When so locked, it cannot be removed except by intention.

This new form of chain is being made in all standard sizes, of the same materials and workmanship and at the same price as the makers' regular Diamond riveted chains. The links and other parts of each are interchangeable with each other, and detachable links may be used for replacing those of the older type. The neat appearance and unusually compact design of the new chain are plainly shown in the engraving.

NO. 2 "MARVEL" DRAW-CUT HACK-SAW.

The power hack-saw shown herewith is made by the Armstrong-Blum Mfg. Co., 113 N. Francisco Ave., Chicago, Ill., and is called by its makers the No. 2 "Marvel" draw-cut hack-saw. A number of original features are included in its design. One of these is the method of feed employed; instead of using a weight, as with the usual construction, the saw is pressed down on the work by the action of a compression spring seen projecting from the front of the machine at the left of the engraving. This spring draws on a rod which reaches back to the guiding frame of the hack-saw which is thus forced down into the work. The pressure of the saw on the cut and the consequent rate of feed may be varied by adjusting the thumb-screw against which the spring bears. The pressure of the saw is relieved on the return stroke. This is effected by an eccentric just back of the saw crank, which relieves the compression on the feeding spring as the saw comes back, and stiffens it up again on the draw, or cutting stroke.

Means are provided for raising and lowering the saw frame and holding it in any position. This is a great convenience

A Hack-saw with Spring-operated Feed releasing on Return Stroke.

in measuring. The frame is guided, as shown, by a square bar directly in the line of travel of the saw. The crank by which it is driven is slotted to vary the stroke from 4 inches to 6¾ inches. The wear can be taken up in the bearings of the saw guide rod so as to permit of good work throughout the life of the machine. The drive shaft has bronze bearings. The starting lever and automatic stop are at the front of the machine. This tool has a capacity for work up to 6 by 6 inches on the long stroke, and up to 8 by 8 inches on the short stroke. It takes blades from 12 to 17 inches long.

The heavy vise furnished can be swiveled in either direction, so that the cutting of angles is conveniently provided for. The entire vise can be removed, leaving a T-slotted table for holding irregular shapes. The vise itself will be found a useful tool for holding work on the drill press, milling machine, etc.

SEARIGHT COMPOUND-LEVER MECHANICS SHEARS.

The mechanics' shears or snips shown herewith are made by the Detroit Shear Co., Detroit, Mich. They have the advantage, as may be readily seen, of bringing into small space and

convenient form all the power that is obtainable from much larger and heavier instruments. They are designed for small work in all mechanical lines. The tool is 7 inches long, and weighs only 5 ounces, but has the cutting power of a 12-inch tinner's snip.

The arrangement of the levers will be easily understood from the engraving, and it will be seen that a toggle-joint action is introduced which gives a more powerful leverage when the jaws are cutting near their points. In other words,

A Compact Pair of Snips, with the Power of a much Larger Tool.

the mechanism is such that the shears cut with equal facility throughout the whole length of the blades. This is a feature not found in other tools of this kind. The blades are curved slightly away from the cutting edges, for cutting circles or square corners. They are made of Ibsen steel, tempered and drawn by the Mallatt process, and nicely finished. These snips will cut tin, soft steel or galvanized iron up to 26 gage, and soft brass or copper up to 20 gage.

MUELLER 2½-FOOT CONE-DRIVEN RADIAL DRILL.

In Figs. 1 and 2 are shown the smallest size of a line of short-arm cone-driven radial drills built by the Mueller Machine Tool Co., Cincinnati, O. These machines are an evidence of a growing tendency to do work on the radial type of machine which was formerly handled on the upright drill press. To meet the conditions of the work for which it is intended, close attention has been given to the matter of providing the greatest possible convenience in operation; in fact, practically all of the conveniences of the builders' line of standard radial drills have been retained. Special effort has been made, however, to produce an inexpensive design, to meet the requirements of purchasers whose work does not require a high-priced radial machine.

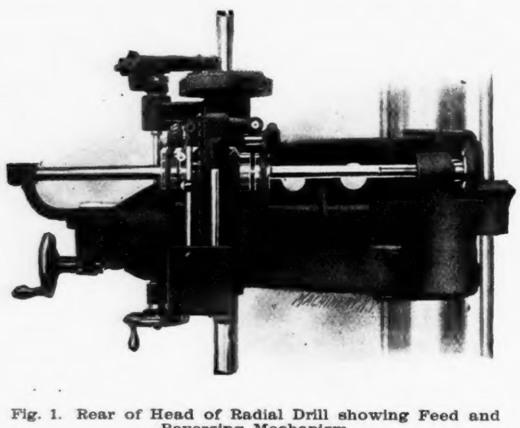


Fig. 1. Rear of Head of Radial Drill showing Feed and Reversing Mechanism.

The framework of the machine is strongly designed and carefully built. The stationary column is of heavy section, bolted to the base by a flange of large diameter. A pipe section arm is employed, which is very rigid against the torsional force produced by heavy drilling. It is clamped to the column by the two handles shown, and is adjusted vertically by a power movement, controlled by an easily reached lever. The head is traversed by a double threaded screw and is equipped with a firm locking device.

Ten changes of speed are provided, immediately available. The correct speeds for all classes of drilling within the range of the machine are shown on a bronze plate attached to the arm, thus enabling the operator to select the proper speeds at a glance and change them while the machine is in motion. A tapping attachment is provided, which is so arranged in connection with an adjustable gage screw as to permit the tap to slip when it reaches the bottom of the hole. The starting, stopping and reversing lever is conveniently located on the head, directly in front of the operator. Four feed changes are provided, so selected as to be especially adapted to high-speed drills. The changes may be made while the drill is at work, the mechanism being similar to that described for another machine by the same builders, in the August, 1907 issue of MACHINERY. Either a positive or a friction feed may be employed as desired. All gears, both spur and miter, are planed to theoretically correct outlines. All shafts as well as the column itself are ground to size.

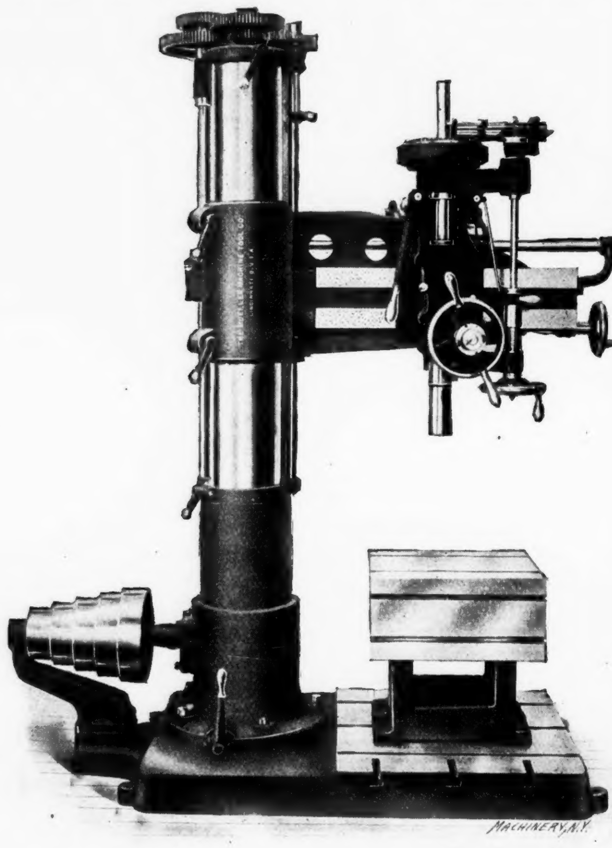


Fig. 2. A Small Radial Drill of Simple and Convenient Design.

Any style of table desired will be furnished. These machines are made in 2½, 3 and 3½ foot sizes.

BLISS DOUBLE CRANK TOGGLE DRAWING PRESS.

The machine shown herewith, built by the E. W. Bliss Co., No. 5 Adams St., Brooklyn, N. Y., is designed for the simultaneous drawing and stamping of large forms of irregular shapes, such as required for trays, stove tops, seamless roasters and an extended line of similar work. The usual press for work of this kind is of the double crank type, with a spring-actuated blank holder. Where work has to be drawn to any considerable depth, the use of blank holders of this kind is objectionable, since there is a varying pressure on the work, increasing from the beginning to the end of the operation. This means also a larger power consumption than would otherwise be necessary, since the pressure on the blank, if of the proper degree at the beginning of the operation, is much greater than necessary at the bottom of the stroke. In the press shown herewith a toggle mechanism is used which gives an even holding pressure and a consequent reduction in power consumption.

The original design of this press was brought out three years ago. It has been redesigned, however, embodying such changes and improvements in detail as recent experience has indicated to be advantageous. The frame is heavy, and cast in one piece. The crank-shaft is of high carbon, hammered steel, and of very large diameter. The punch slide has its pressure applied by two cranks, which may be adjusted for length simultaneously by means of screw connections which are geared together and work in unison, assuring accurate alignment at all times. This adjustment is effected by the operation of a ratchet lever.

The blank holder slide surrounds the punch slide, and receives the pressure evenly distributed on four points through the heavy steel screws shown. This slide is operated by the makers' patent toggle motion, which has been used with satisfactory results for many years. The toggles which are of steel, are operated from rock-shafts through an outside slide, which is operated by a crank connection on the end of the main crank-shaft. The blank holder slide mechanism is balanced, to avoid undue strains. The construction gives assurance that all the strains borne by the blank holder will be taken up by the press frame. A knock-out is provided, actuated by the blank holder slide.

The press will receive and work a 42- by 22-inch blank of No. 14 gage steel, or smaller blanks of heavier stock in proportion.

It will take a drawing punch 12 by 36½ inches. The press makes 30 strokes per minute, with the driving shaft running at 205 revolutions per minute. The stroke of the punch is 8 inches, and that of the blank holder is 6 inches. The floor space occupied is 12 feet 2 inches, by 7 feet 3 inches over all, and the weight of the machine complete is approximately 42,000 pounds.

MUMMERT, WOLF & DIXON HIGH-POWER PLURALITY DIE BOLT-CUTTER.

In the August, 1907, issue of MACHINERY, in the department of New Machinery and Tools, we described a plurality die bolt-cutter built by the Mummert, Wolf & Dixon Co., Hanover, Pa. This firm has recently developed a single speed pulley gear-driven machine, illustrated and described herewith, working on the same principle but incorporating a number of improvements in design, especially fitting it for the use of high speed steel chasers.

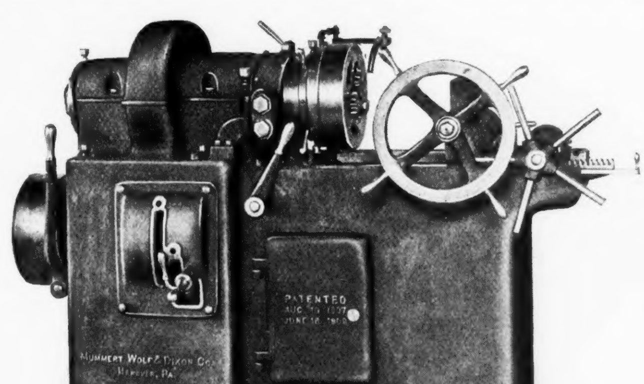
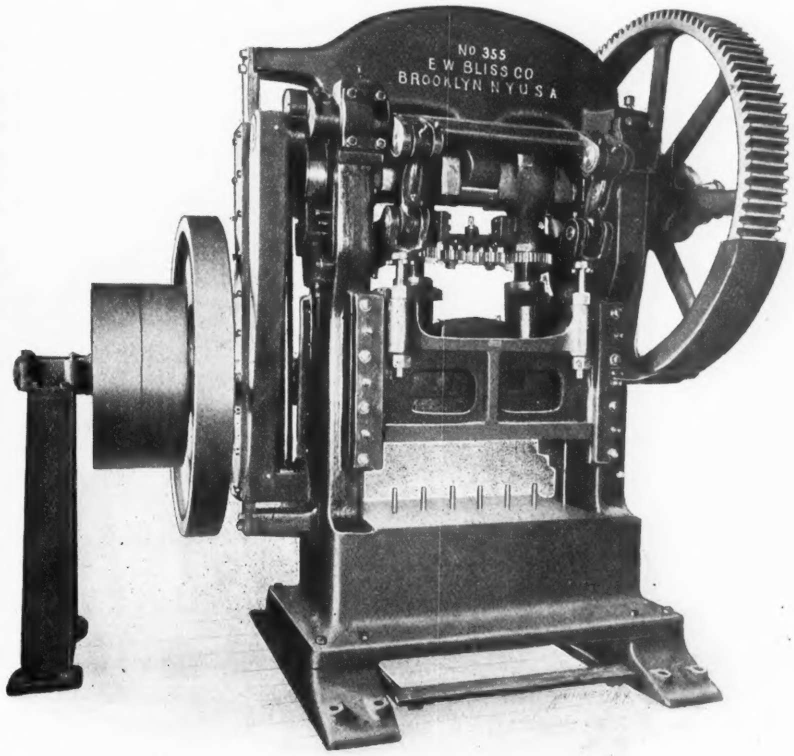


Fig. 1. A Plurality Die Bolt-cutter, adapted to the Use of High-speed Steel Chasers.

The principal feature of novelty in this machine, it will be remembered, is the construction of the die-head. This carries three multiple chasers as shown in Fig. 2. Each of these has six cutting faces, and they may be adjusted so as to cut any one of six pitches of thread. The head in which they are mounted permits adjustment for size without stopping the spindle, by turning the internal threaded collar A (Fig. 3) by means of handles B with which it is provided.



A Press for Simultaneously Drawing and Stamping Large Work.

The head is operated either automatically or by hand. The adjusting collar is graduated so that it can be set to the required diameter without the usual cut-and-try operation. The head when closed for threading is positively locked. The multiple chasers shown in Fig. 2 differ from those previously illustrated, in that inserted blades of high-speed steel are employed, set in soft steel bodies.

The driving gearing is plainly shown in Fig. 3. A constant speed driving pulley may be connected or disconnected from driving shaft by the operation of the clutch shown. This makes the use of a counter-shaft unnecessary. The triple tumbler gear arrangement, shown at C, operated by the handles seen projecting through the base in Fig. 1, is employed for giving the various speed changes. Any one of the three gears on stud C may be set to engage with the driving gear D on the spindle. It will be seen that this mechanism is simple and direct. All the gearing is enclosed within a frame. The base has a solid bottom, and is so constructed that all the oil drains to the suction pipe of the pump, which is enclosed within the frame. The oil tank at the bottom is provided with an overflow division, which serves to catch particles of metal which may be carried with the oil past the chip pan E. These metallic particles naturally settle to the bottom of the first compartment, while the top oil is delivered to the pump in a fairly well filtered condition, thus reducing the wear on the pump, as well as delivering a clean stream of oil on the dies when cutting. As this oil naturally permeates the mechanism of the head when in

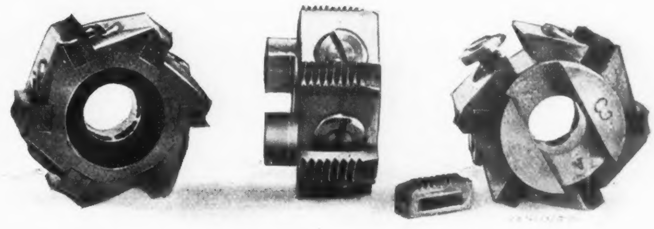


Fig. 2. Style of Chasers used, having Inserted Teeth.

use, the grit would otherwise work into the wearing parts and reduce the life of the mechanism to some extent. The vise jaws on the carriage can be adjusted off the center, side-

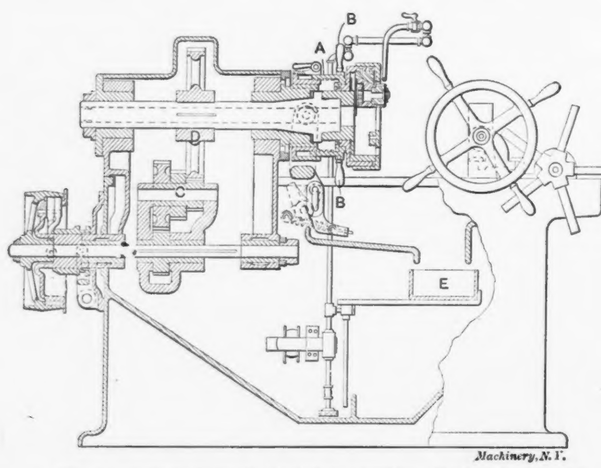


Fig. 3. Section through Machine, showing Driving Mechanism.

wise, when an irregular-shaped piece is to be held. A dowel pin locks it in the central position.

MOTOR-DRIVEN GUN BARREL DRILLING AND RIFLING MACHINERY.

The Pratt & Whitney Co., Hartford, Conn., has been known from the beginning of its existence for its line of machinery adapted to the manufacture of fire arms. It has, in fact, done much in the way of completely equipping armories in all parts of the world. The well-known Lincoln milling machine was first developed for this work, and other machine tools now in common use for other purposes were first particularly applied to the making of fire arms. Two most important machines for such work are the gun barrel drilling machine and the rifling machine. The former of these has been adapted to the general drilling of deep holes in ordinary shop practice, as well as for the special work for which it was originally designed. The rifling machine is, of course, still a special tool not used outside of fire arm factories. While retaining their original principles, these tools have been recently redesigned, particularly in the largest sizes, and have been adapted to the motor drive.

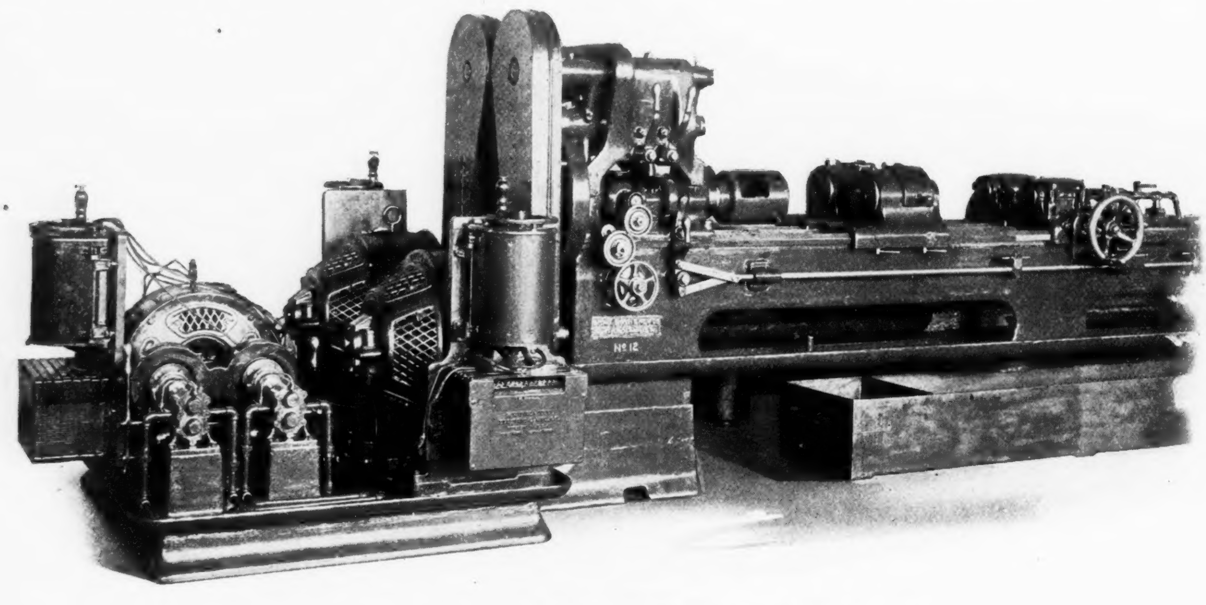


Fig. 1. Large, Motor-driven, Pratt & Whitney Gun Barrel Drilling Machine.

In Fig. 1 is shown the largest size of the gun barrel drilling machines, called by the makers the No. 12. It is motor-driven, as may be seen, there being a separate drive for each of the two spindles and a third for the oil pumps which form a very important part of the mechanism. The separate drive for the spindles allows the work to be done to the best advantage, as they may be operated as two separate machines. The general arrangement of the mechanism is well-known. On the outer end of the spindles are chucks for holding and revolving the gun barrel, or other part to be drilled. The outer ends of the work are supported by bushings in the brackets shown, which are adjustable to any desired point on the bed. The drill holding carriages are provided with chucks for holding the drills by their shanks. These carriages have independent hand and power feed, driven from the spindles, with automatic knock-off. The mechanism is such that any abnormal resistance to the full cutting action of the drill arrests the feed. Two rotary oil pumps are provided, one

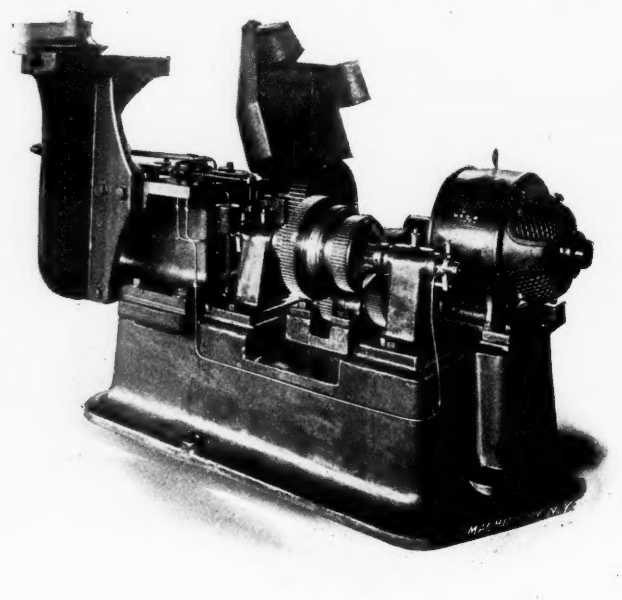


Fig. 2. Driving Mechanism of Rifling Machine.

for each drill. These continuously force oil from a large tank underneath the machine through telescopic tubing into the drill. The oil not only cools the cutting edges, and gives a fine finish to the work, but serves also the very important office of carrying off the chips from the deep holes. The oil carrying the chips flows into a basin in the tank, where the chips are separated; the oil then returns to the reservoir for use again. In large installations, it is often considered best to install a single high-pressure pump to supply oil to all the machines, doing away with the individual service for each tool. The drill used is of the single lipped type, with a spiral closed channel in its periphery which leads the oil to its cutting edge. This cutting edge is in the form of a series of steps which break the chip and make it more easily

removed by the flow of oil. This is especially useful on large drills, and provision is made for grinding these steps in the grinding machine furnished with the equipment.

Four sizes of rifling machines are made, of which the largest (the No. 5) is shown in Figs. 2 and 3. This has a head for holding and indexing the gun barrel, and a sliding carriage, provided with a spindle for carrying the rifling bar. Over the carriage is a bracket, as shown, carrying an adjustable taper bar, which, in combination with the longitudinal movement of the sliding carriage controls the rotation and pitch of the rifling bar, by means of a transverse movement given to a cross-slide, carrying a rack; the latter is in mesh with a gear on the rifling bar spindle. The taper or former bar is pivoted at the central point, and may thus be adjusted to give a true helix of any desired twist. Where an "increased twist" is required for the rifling, the form bar is curved to suit the requirements.

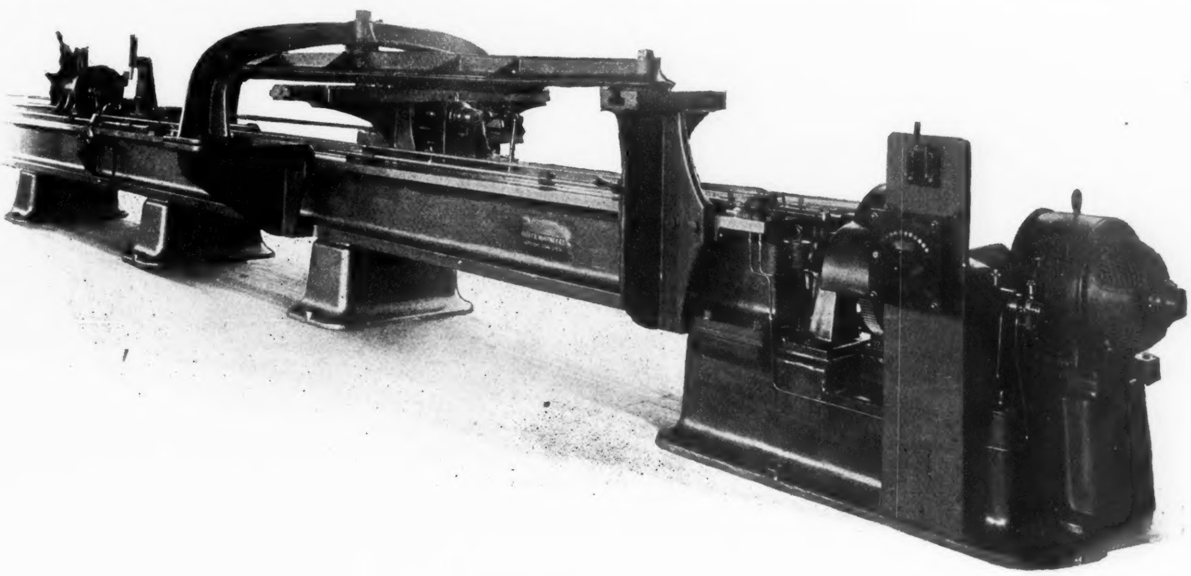


Fig. 3. No. 5 Rifling Machine.

The carriage travels backward and forward continually, being controlled by an automatic reversing mechanism. In the case of this large machine a pneumatic control is employed. A stop rod which extends along the front edge of the bed in Fig. 3, operates a valve at the upper left of Fig. 2, controlling the air pressure in pipes leading to each end of the reversing spindle shown in the foreground. This reversing spindle has two loose gears mounted on it, driven directly and through intermediate gearing from the motor, so as to run in opposite directions. The friction clutch pneumatically controlled by the valve just mentioned, connects either of these gears with the shaft, which, in turn, carries a pinion meshing with the driving gear of the lead-screw which operates the sliding carriage.

In the smaller machines, the work is indexed automatically at the end of each stroke. On the larger machines this indexing is done by hand. Suitable provision is made for getting rid of backlash in the indexing device. The smaller machines also are completely automatic, to the extent that after the carriage reversing dogs and stock nuts are adjusted, and the barrel is placed in the head and clamped, the machine, being started, causes the carriage to travel backward and forward continually, indexing the rifling bar head at the end of each stroke, and feeding out the cutters automatically until the grooves have been cut to the proper dimensions. The feed is then discontinued, and the machine is stopped by the operator for the removal of the work.

Figs. 4 and 5 show the form of rifling tool used for large work. The whole tool may be rotated for adjustment around the bar, to match grooves previously cut. The tool cuts on the draw stroke, producing grooves free from chatter marks. The blades are automatically withdrawn from contact with the work on the return stroke, so that the slot and the keen edge of the cutters are preserved from damage. In smaller work, of course, a single bladed cutter is used, in which the automatic feeding and relieving provisions are retained. Mechanism is provided to automatically remove any chip that may lodge in front of the cutter.

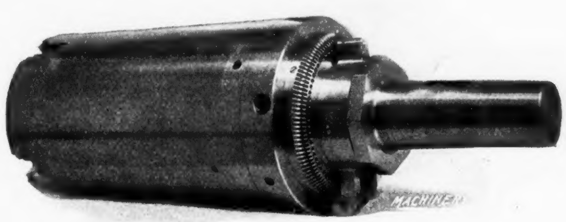


Fig. 4. A Large Rifling Head, showing Rotating Adjustment.

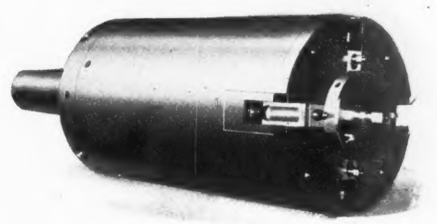


Fig. 5. End of Rifling Head, showing Adjustment for Depth of Cut.

LYON EXPANSIBLE STEEL RACKS WITH ADJUSTABLE SHELVING.

The Lyon Metallic Mfg. Co., Aurora, Ill., has developed a system of steel rack construction, combining to an unusual degree the qualities of strength, convenience, adjustability and simplicity. The manner in which the details of the design have been worked out, as shown in the accompanying illustrations, gives evidence of careful thought, and full appreciation of the requirements which shop furniture of this kind must meet.

As is shown in Fig. 1, the rack is built up of upright partitions, tie-rods and shelving. The shelving rests on the tie-rods which are made in separate lengths for each section, but are threaded together onto continuous rods for all shelving on the same level. The tightening of the rods puts them in tension, and the flanged edges of the shelving in compression, making as rigid a construction as is possible for any structure built of members placed at right angles to each other. The strength of the various members and their method of holding permits each section to take care of its own load, without requiring the additional stiffening effect of adjoining members. When a number of units are bound together, how-

ever, the carrying capacity is increased above that guaranteed. The stated capacity of the shelves makes provision for uneven loading, so that care does not have to be taken in this particular. No diagonal braces are required, thus making the shelving equally accessible from front and back.

The upright partitions are made of 20-gage cold-rolled sheet steel of special manufacture. The edges are faced and bound on each edge with doubled and beaded strips of 12-gage steel, which greatly increase the stiffness of this member, which is specially rolled from a metal high in carbon. The upright partitions are alike on each face and each end, so that they may be assembled either side to, or either end up. The face strips are all punched with holes spaced on 3-inch centers, thus permitting the adjustment of the shelving to 3-inch dimensions.

The shelves are each made of a single piece of No. 16 gage, patent leveled, cold-rolled steel. The front and back of the shelf is given three continuous right-angled turns, each, as is shown in Fig. 3, leaving a smooth 1-inch surface at the front of the shelf, an equal parallel surface underneath, and

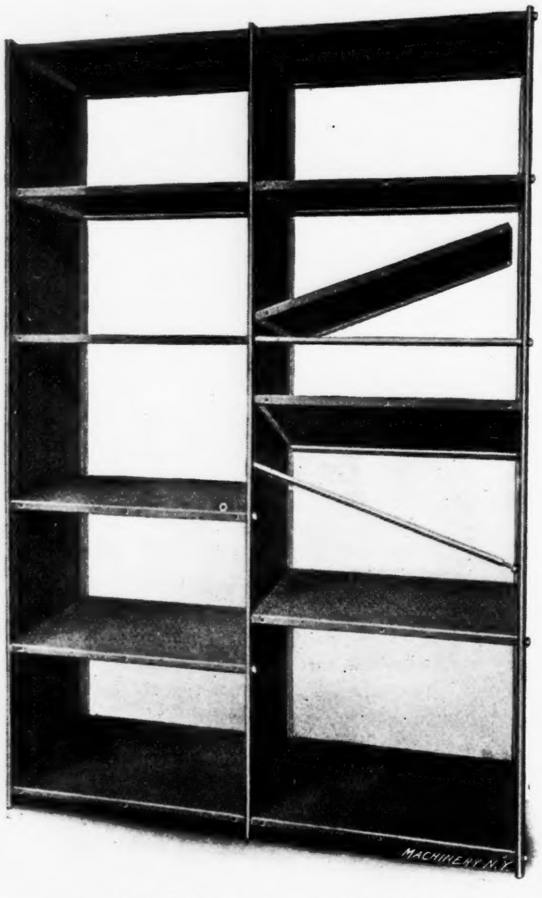


Fig. 1. Sectional and Expansible Steel Rack.

an inner flange projecting upward inside. This makes a smooth finish and strengthens the shelf, as well, at the points where strength is most required. This strength at the front and back of the shelf is increased by the tie-rods which pass through and immediately in back of this flange. This is the place where an overload is likely to occur, as it is natural when hoisting a heavy weight into position to raise it a little above the shelf and drop it on the edge of the shelf for a rest before it is pushed into place. The shelves are reversible, and fit snugly against the partition so that even the smallest materials are prevented from dropping through.

The connecting rods, shown in Fig. 2, by which the vertical sections are tied together and the shelves supported, are made, as explained, in lengths to suit the width of each section. They are made of No. 16 gage, but jointed steel tube, 7/8 inch in diameter. Each tube is fitted at the end with a threaded stud-bolt, which is brazed in place. At the other end is a steel bushing, which is tapped to receive the stud-bolt of the adjoining rod. At the outside of the partitions, tap bolts are used at one end and nuts at the other, as is also the case where a shelf is at a different height from those in the adjoining section. Making each rod the length of the shelf permits independent adjustments. A simple pin wrench entering the holes shown in the tubing is used for screwing the parts together.

Numerous special conveniences are provided for adapting this shelving to the varied work of the customer. Fig. 3 shows an attachment which converts the shelf into a bin, when it is desired to store loose materials. This can be fitted to flat shelves already in position, without making any alterations whatever. It is locked over the front flange of the shelf, as shown, thus forming a tight joint for the whole length of the front. Adjustable angle clamps fasten it to the verti-

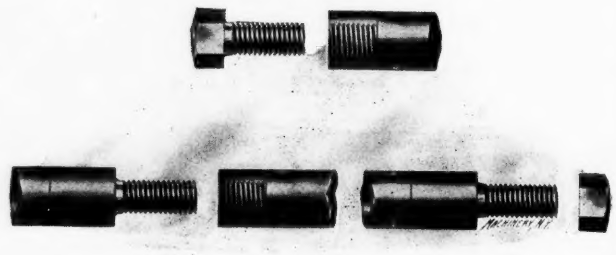


Fig. 2. Design of Tie-bolts used for Holding Rack together and Supporting Shelves.

cal partitions at the ends. This attachment makes the shelves so tight that leakage is prevented even when such materials as seeds and other fine stuff are placed therein. The interlocking flange at the bottom prevents the attachment from bulging out, even when subjected to pressure from within. At the same time it strengthens this shelving against both vertical and lateral strains.

A shelf extension is provided which may be used on the lower portion of the rack after the regular shelves have been installed, to increase their capacity, or to convert them into large bins. They consist of upright partitions of the same construction as the uprights, which are attached to the facing strips of the racks already in position by means of clips. The shelves can then be installed on a line with the rack shelving, making one continuous shelf throughout.

A number of minor conveniences are provided. Label holders are furnished for attachment to the front of the shelves. They are held in place by three longitudinal clips or tongues punched on the metal, which register with corresponding square holes in the face of the shelf. They are fastened in place by pressing them backwards with a special tool provided for the purpose. When it is desired to use boxes in the shelving reaching approximately half the depth of the

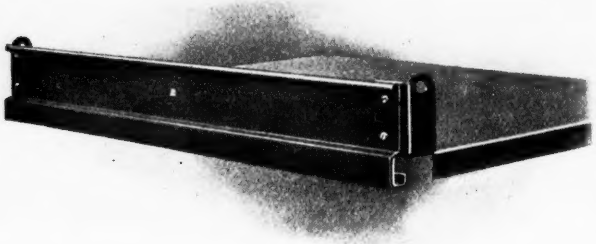


Fig. 3. Rim Attachment for Converting Shelf into Storage Bin.

shelf, a box stop is fastened to the center of the shelf, which prevents the box when being pushed into position from displacing another immediately back of it. A back stop for the rear side of the shelf may also be provided when large boxes are to be stored from one side only; or, if desired, complete backs may be fastened to each section of shelving by means of clips.

Removable partitions are provided by means of which shelves may be divided lengthwise from end to end. The shelves are punched with holes every six inches for this purpose. The partitions are the same depth as the shelves, and are furnished in heights to fit into the clearance permit-

ted by the 3-inch height adjustment. Bracket shelves may be attached to any sections or to all the sections in a series. They are fastened to the uprights, and are convenient for resting boxes when desired, or as a counter for sorting material. They are strong enough to hold the weight of a man should it be desired to use them for a step for reaching shelves higher up.

These shelves are furnished in a wide variety of sizes to fit every imaginable requirement on the part of the customer. While no effort has been made in the way of ornamentation, the simplicity of the design and the general smoothness of finish give the whole arrangement a strong and pleasing appearance. All the parts are regularly finished in a good durable quality of black enamel, which protects the metal as well as adding to its attractiveness. Other and lighter colors may be used if it is required. This is advisable where the room in which the racks are to be used is dark, as the light will be increased by reflection.

FILING ATTACHMENT FOR THE POWER HACK-SAW.

In the department of New Machinery and Tools of last month's issue of Machinery, we illustrated the "Royal 1909" power hack-saw made by the Robertson Drill & Tool Co., 1848 Niagara St., Buffalo, N. Y. It will be remembered that in this machine, the drive is carried in a frame *A*, pivoted about the driving shaft. As this frame also carries the guides *B* for the saw holder, it is possible to tip the whole mechanism to any position about the axis of the driving shaft. This peculiarity of construction allows the saw, with suitable attachments, to be used as a filing machine in the way illustrated in Figs. 1 and 2.

Fig. 1. Robertson's "Royal" Power Hack-saw arranged to be used as a Filing Machine.

The filing table *D* and supporting arm *C* are mounted on the bed. The file *E* is supported at its lower end in a cone-shaped cup *F* set on a stud where the saw is ordinarily connected. On the upper end is a special threaded socket *G* having a hole to receive the file tang, on which it is tightened by a knurled nut. The swiveling adjustment of the hack-saw frame provides for the filing of any desired angle, or relief for die work. It can be used for the regular work of the filing machine for cutting out the centers of dies, etc. This device can be applied to the machine at any time, as proper provision for attaching it is made in the original design.

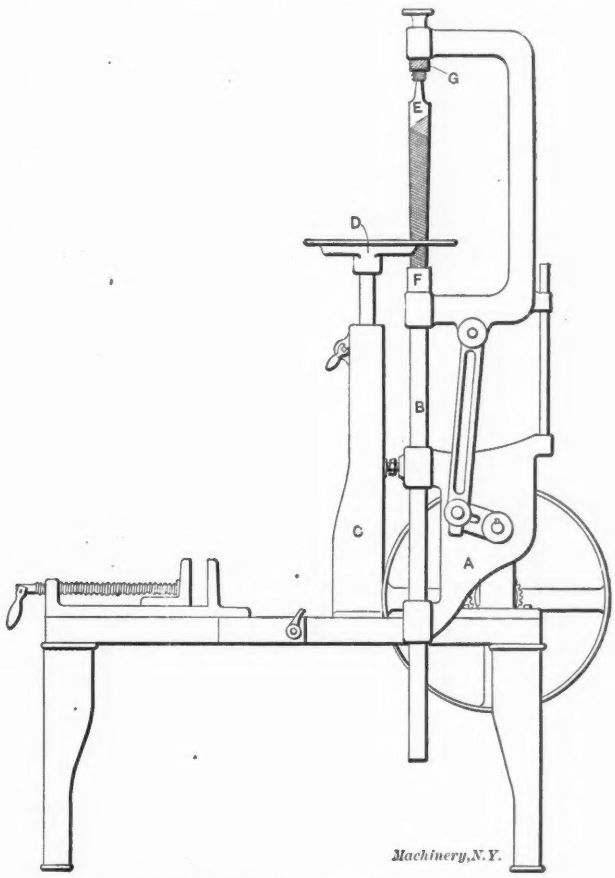


Fig. 2. Details of Mechanism of Filing Attachment.

GRAHAM KNURL HOLDER FOR TURRET MACHINES.

The Graham Mfg. Co., Providence, R. I., is making the knurl holder shown herewith. It is adapted to be used in the turret heads of lathes, screw machines, chucking machines, etc. The advantages of this tool are, first, that it is adjustable to any size within its range (that is, for work up to 2½ inches in diameter by 2½ inches long); second, the knurls work on opposite sides of the material, so the pressure is equalized and there is no tendency to push light stock to one side, and it is thus possible to knurl to a very small diameter; third, it leaves the cross-slide tool-post free for the use of any special tool that may be required, not suitable for the turret head itself.

Fig. 1. An Adjustable Knurl Holder.

The knurl holder is held by the usual round shank *A*, of a diameter to fit the hole in the turret. This shank is bored to permit the passage of long work, and has an offset boss holding a finished bar of stock *B*, on which slide two projecting arms *C*, to which the knurls *G* are pivoted. Bar *B* is splined to engage a key on each arm *C*, thus holding the

knurls in line with the axis of the shank. A right- and left-hand screw *D* is threaded in tap holes in the two arms. It is locked against endwise movement by clip *E*, which engages a recess turned in its shank. By turning this screw with an ordinary screw-driver, the arms are adjusted to suit different diameters of work. When the correct size is obtained, the clamping screws *F* in each arm lock the adjustment.

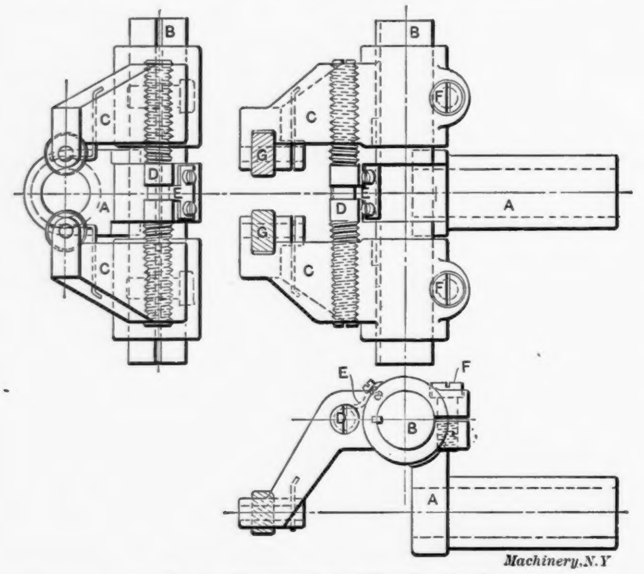


Fig. 2. Construction of Knurling Tool.

The peculiar shape of the tool is the result of experiment in giving a construction which would clear the other turret and cross-slide tools, and would at the same time be simple to manufacture. The device may be fastened in the turret at any angle that may be necessary for clearance, or to bring it to a position where its work can be watched by the operator.

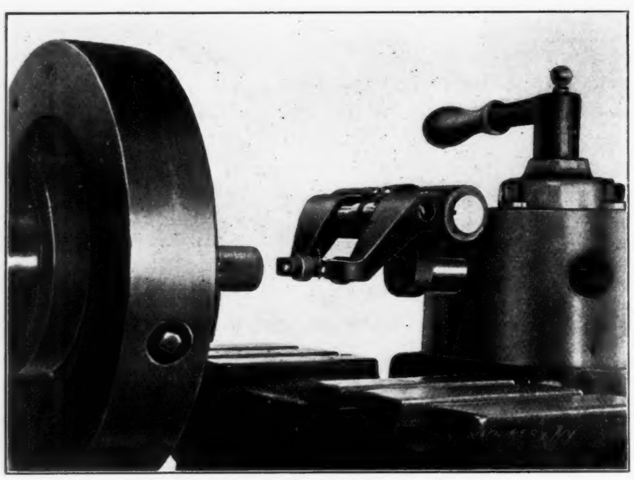


Fig. 3. Tool in Use in Turret Lathe.

The knurls *G* are mounted on pivots, which are held in place as shown by wire springs with projecting ends, which enter notches cut in the pivots. These notches are provided at each end of the pivots, so that the latter may be reversed, doubling their life so far as wear is concerned.

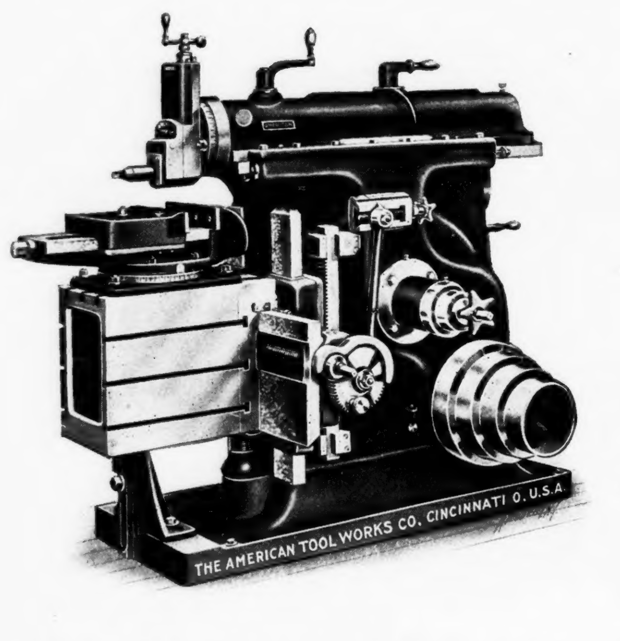
AMERICAN TOOL WORKS BACK-GEARED CRANK SHAPER.

The accompanying engraving shows the 21-inch size of a new line of back-geared crank shapers built by the American Tool Works Co., Cincinnati, O. These tools are of new design throughout, based on the results of investigation into the needs of shaper users, and experience of these tools in the shops of builders. They are intended to combine the accuracy required in tool-room work with the qualities demanded of a machine which is to be used for manufacturing purposes.

An inspection of the illustration shows that much care has been taken in the design of the column and other main members of the structure. The column, base, ram and table are all of heavy section and internally braced. The column projects both front and rear at the top, providing a very long bearing for the ram. The latter is designed to give uniform rigidity as nearly as possible throughout the length of the stroke. Its bearing on the column is taken up by a continuous taper gib, with end-screw adjustment for wear. The apron is similarly gibbed to the cross-rail, which is of box form and strongly ribbed. An improved arrangement of the bearing on the column prevents the cross-rail from dropping when the binder bolts are loosened. A telescopic elevating screw is provided to obviate the necessity for boring holes in the floor.

The stroke of the ram can be varied from 7.7 to 96 per minute with eight changes. The length of the stroke can be adjusted without stopping the machine, as can also the positioning of the ram, effected by turning the crank shown just back of the head. The rocker arm is heavy and thoroughly braced, and operated by mechanism so proportioned as to give a nearly uniform rate of speed throughout the entire stroke. A convenient self-locking lever at the rear of the machine throws the back gears in or out. The driving ratio with back gears is 24, 3 to 1, which, with the large cone pulley used, gives great driving power.

The cross-feed, as may be seen, is of the planer type, which does not have to be adjusted in any way when raising or



A Back-geared Shaper designed for both Accuracy and Output.

lowering the table. It can be set to give from 0.008 to 0.200 inch when the machine is running, by means of the slotted crank shown. The feed is thrown in or out or reversed by a knurled knob on the large feed gear.

The gears are of coarse pitch and wide face, with pinions cut from bar steel. The bevel gears are planed from solid. All the shafts are of high carbon crucible steel, ground to accurate size. All the points of danger are protected, while easy access is provided to the working parts by a large door on the rear side. Special attention has been given to the matter of lubrication, for the sake of insuring long life and service from the machine. The ram slides are protected and provided with felt wipers, and are oiled from central pockets. The distribution is effected from the wipers, which distribute the lubricant throughout the whole length of the slides, thus doing away with oiling through a multiplicity of holes. Waste oil is received in a pocket at the rear of the column, where it may be drawn out from time to time. A large quantity of oil is stored in a pocket in the arm, which is distributed for the crank-pin and sliding bracket in the rocker arm.

These shapers are made in six sizes, the 15, 16, 18, 21, 25, and 30 inch stroke respectively, all being back-geared with the exception of the 15-inch stroke. The machines are regularly furnished with the heavy vise shown and with all necessary wrenches. At extra cost, the makers will provide a table support, an automatic feed stock for the cross-rail, power down feed, circular attachment, special vise and table

for mold-makers, tilting top for box table, universal table with tilting side, four-speed gear box, and electric motor drive.

CHICAGO BENCH FILING MACHINE.

The bench filing machine shown herewith (built by the Chicago Filing Machine Co., 5-17 West Madison St., Chicago, Ill.) is particularly adapted to small die work. It has a num-

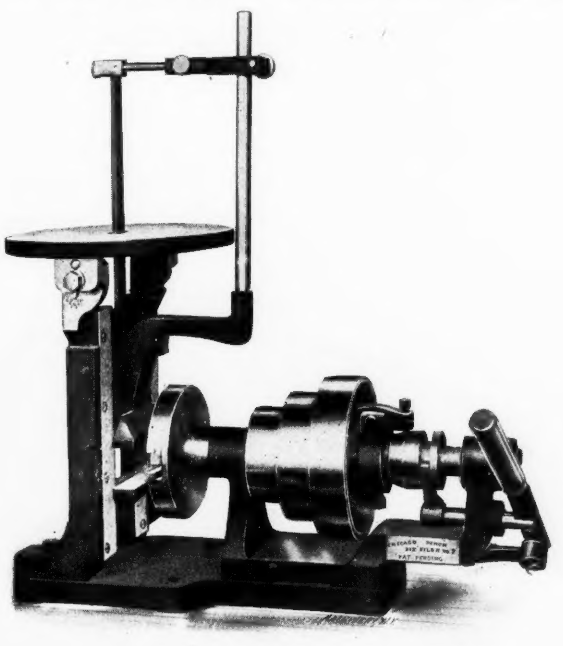


Fig. 1. Bench Filing Machine, suitable for Die Work.

ber of advantages in the way of simplicity, improved methods of holding the file, and ease of operation.

The file holder is shown in Fig. 2. It consists of a tilting base *A*, against which the tang of the file *C* is clamped by two knurled screws *B*. This operation permits the file to be adjusted to bring it to the proper position for the top clamp, without danger of springing it. It will also grasp the outer end of the file as firmly and safely as the tang, so that the machine may be arranged to cut on the down stroke as well as the up stroke, where this is found desirable. It will be seen that the matter of changing the file is one of the greatest simplicity. The upper support may be swung out sideways, to remove the work for inspection without affecting the adjustment of the file.

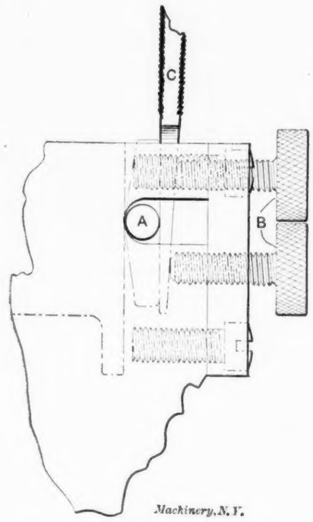


Fig. 2. Clamp for Gripping File.

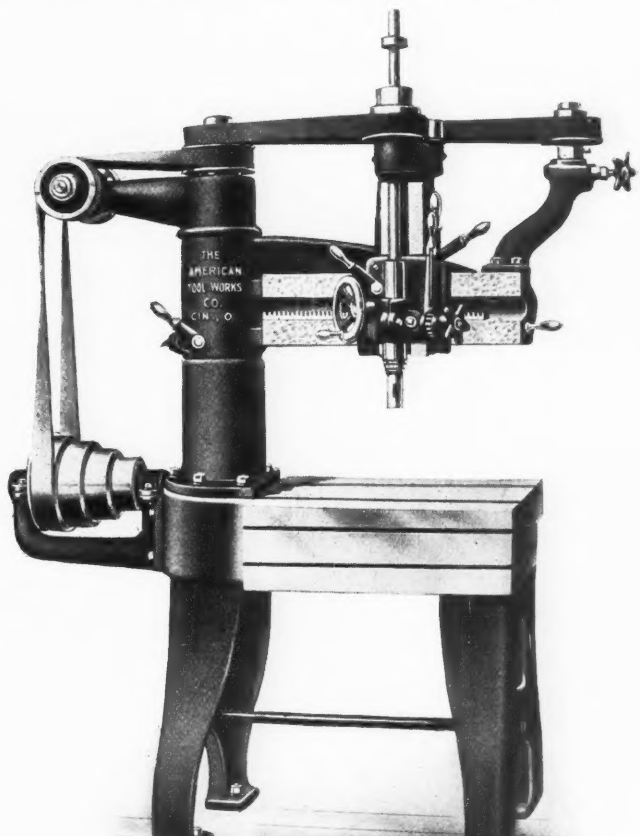
As shown in Fig. 1, the machine is provided with a clutch for quick starting and stopping. The counter-shaft furnished carries a three-step cone and tight and loose pulleys. The file slide has V-bearings, with adjustment for wear. The table is 8½ inches in diameter and tilts 10 degrees either way. The height to the top of the table is 11 inches. The weight of the machine and counter-shaft is 70 pounds.

AMERICAN TOOL WORKS SENSITIVE RADIAL DRILL.

The half-tone illustration shows what we believe to be the first sensitive radial drill, of the standard radial form, made in America. As may be seen, the spindle is carried on a head adjustable in or out on a swinging arm, while the work is supported on a stationary table. This tool is particularly adapted to the use of small size drills up to ¾-inch, on parts of small or moderate size. This includes such work as the drilling of switchboards, automobile chassis, cash registers, harvesting machinery, etc. The machine combines the sensitiveness of the high-speed drill with the convenience and effectiveness of the radial type.

The general design of the machine provides for locating all levers directly at the operator's hand, so that the movement of the head and arm and the feeding of the spindle are quickly and easily accomplished. The arm is of parabolic beam and tube section, to give the proper resistance to bending and torsional strains. It is unnecessary to raise it and lower it, as provision for variable heights is made on the head. This latter consists of a main saddle, sliding on the arm, which carries an auxiliary sliding-head on a vertical dove-tail. The adjustment for the height of work is made by raising and lowering this supplementary head. The adjustment along the arm is effected by a rapid-action rack and spiral pinion. Suitable clamping handles are provided for all adjustments, and full provision is made for taking up wear.

The driving mechanism obviates the use of gears entirely. A double, loose pulley revolving on a vertical stud at the top of the column, is driven from the cone by a belt, and in turn



A Sensitive Drill of Standard Radial Construction.

drives the spindle by a flying belt arrangement, giving a constant tension at all positions of the arm. This tension is adjusted by shifting the position of the idler at the extreme right of the arm. The spindle has six changes of speed, ranging from 300 to 900 revolutions per minute in geometrical progression. It is fed by a long hand-lever and a ratchet wheel, whose latch is self-releasing when in the vertical position. An adjustable stop collar is provided which can be used as a depth gage. A convenient star wheel gives a quick return movement. The table is of the height to enable the average operator to conveniently stand to his work. Both top and front sides are fitted with T-slots planed from the solid, and the back end is planed for convenience in squaring up work, etc. The column is of tubular section, internally ribbed, and extends through the arm to the back at the top of the machine. It is firmly bolted to the top of the table.

Experiments with the smaller sizes of this machine have shown that in ordinary shop practice a ¾-inch drill, making

375 revolutions per minute (73.7 feet per minute cutting speed) will feed at 0.028 inch per revolution in cast iron, drilling at the rate of 10½ inches per minute and consuming 3¼ H. P. The drill is made with either a 2-foot or 3-foot arm, having the same general dimensions, except that the latter machine has a longer table, giving a working surface on top of 20 by 40½ inches. The maximum distance from the end of the spindle to the top of the table is 19 inches, while the maximum distance from the spindle to the floor is 54 inches, the table being 35 inches high. The regular equipment includes a 2-speed counter-shaft without the belts. This machine is built by the American Tool Works Co., Cincinnati, Ohio.

REYNOLDS MACHINERY CO.'S GEAR-HOBBING MACHINE.

In the August, 1908, issue of MACHINERY, we illustrated a spur gear hobbing machine made by the Moline Tool Co., which involved the very interesting and valuable principle of a fixed angular position of the work spindle with relation to the cutter spindle. This resulted in an unusually simple design of machine. The rights to this machine have been acquired by the Reynolds Machinery Co., of Moline, Ill., which

Fig. 1. Gear-hobbing Machine for Hobs of Fixed Helix Angle.

has redesigned it and taken, it would appear, very full advantage of the possibilities offered by the original principle involved.

As has been explained in MACHINERY,* in a gear-hobbing machine the cutter spindle has to be set at an angle with the work spindle to agree with the helix angle of the hob, it being necessary for the teeth of the latter to mesh with the straight parallel teeth of the gear to be cut. In this machine this angle is kept constant by varying the pitch diameter of the hob in direct ratio with the circular pitch of the gears being cut, thus making the angle of all the hobs the same. In fine pitches, when this would bring the diameter too small, multiple threaded hobs are used to bring them up to reasonable dimensions. It will readily be seen that the avoiding of the swiveling adjustment of the cutter slide makes possible a simplification which is radical, to say the least.

Figs. 1 and 2 show right- and left-hand views of the machine, respectively, while Fig. 3 gives a top view, indicating the driving and feed connections somewhat more clearly. The work spindle is mounted on a carriage which is fed horizontally along the top of the knee during the cutting action. The knee on which this work-slide travels is vertically adjustable on the column for diameter of work and depth of cut, by the operation of the inclined hand-wheel shaft at the right of the

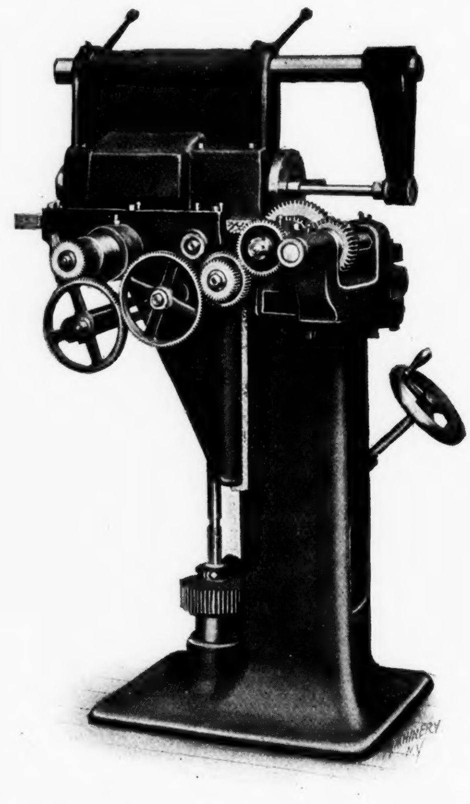


Fig. 2. Left Side of Machine, showing Spindle and Work Drives.

column. The head carrying the hob is fixed in position at the constant cutter angle on top of the column. This makes the problem of bringing the power to the hob as simple as that of driving a milling machine spindle, as there is no need of bevel gears, splined shafts, universal joints or any other

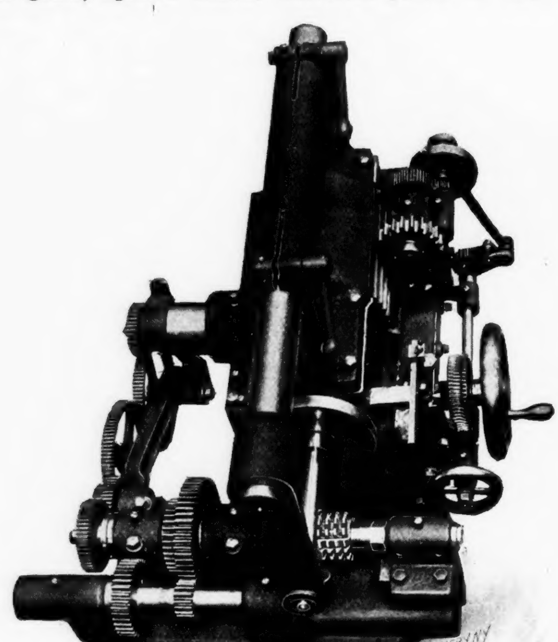


Fig. 3. Top View, showing Back-geared Spindle Drive, Automatic Feed, etc.

similar devices to compensate for the adjustment it is usually necessary to provide. It will thus be seen that the machine is, structurally, of great simplicity.

That the machine is also simple in its mechanism will be realized by tracing the connection between the hob-spindle and the work, and comparing it with the complication usually

* Article on "Gear Cutting Machinery," March, 1908, Engineering Edition.

found necessary for this. The broad face spur gear to which the work-spindle is keyed, is driven by a worm of the same thread angle as the hob. Setting this worm to mesh properly with the parallel teeth of the work-spindle driving gear, brings it into parallelism with the cutter spindle, so that the matter of connecting them to secure the proper rotary speed of the work is as simple as that of gearing the lead-screw of a lathe. The change gearing is mounted on a swinging arm, pivoted to the cutter spindle head at one end, and suspended from the vertical adjustable knee at the other, so that it is possible to adjust the latter for the depth of cut without throwing the gears out of mesh.

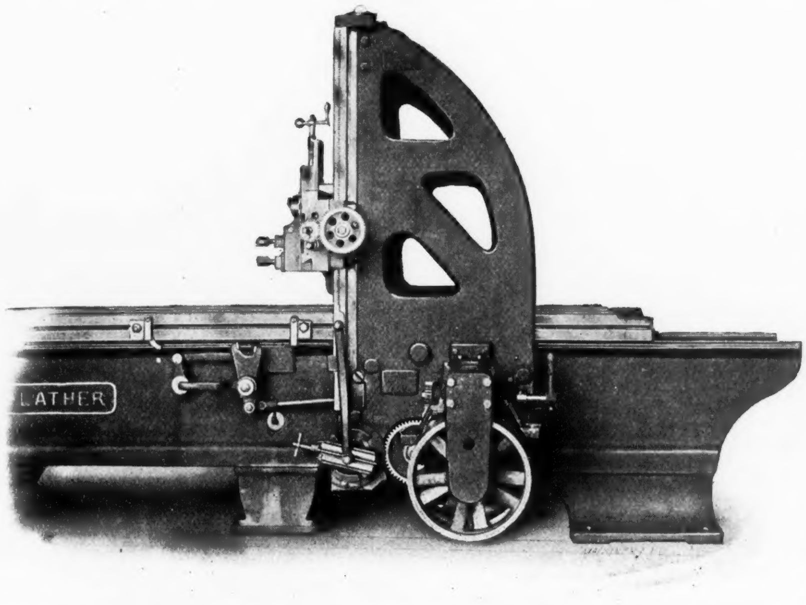


Fig. 1. Thirty-inch Flather Planer, with Two Forward Speeds and Constant Quick Return.

The feed of the work-slide or carriage is effected by two racks on the under side, driven by pinions in a shaft fixed in the knee, and terminating in the hand-wheel shown at the right in Fig. 2. This feed is operated through the worm gearing shown, from a ratchet mechanism, driven by an adjustable slotted crank connected with the work driving gear. An automatic stop is provided for the feed. This, as is plainly shown in Figs. 2 and 3, operates by dropping the feed worm from engagement with the wheel on the pinion shaft. The broad face of the work driving gear permits the full travel of the slide without disturbing its proper mesh with the worm by which it is driven from the hobbing spindle. The racks by which this slide is fed are approximately in line with the thrust of the cut, being a little below on small gears and a little above on large gears. This reduces the wear on the carriage and equalizes what wear there is, so that there is little tendency for the bearings to wear loose in the middle.

The work arbor has a substantial outboard support, as shown, which greatly increases the capacity of the machine and the quality of the work, since it avoids the chattering which often limits the output on work of this kind. The machine is driven by a three-step cone and a 3-inch belt. The hob spindle is back-geared with the driving shaft througn the sliding gear connection shown, giving six changes in geometrical progression. The drive has been proportioned with special reference to high-speed hobs, which it is guaranteed to be capable of driving to their limit. The size shown will cut up to 6 diametral pitch in steel and 5 pitch in iron. The dimension limits are 12 inches pitch diameter and 6-inch face. The machine weighs about 1,400 pounds. It is expected soon to place other sizes on the market.

FLATHER TWO-SPEED PLANER WITH CONSTANT RETURN.

The Mark Flather Planer Co., Nashua, N. H., is building the two-speed planer shown herewith, which is designated as the "Rapid Action" type. In the minds of the builders, there are serious objections to many of the methods which have been tried for increasing the ouput of the planer. Some of these designs have been commercially successful, while others have not held their places as factors in the field. Among the new constructions which have been tried are: Accelerating mechanisms for the forward stroke and for the return stroke; and planers with 2-, 4- and 6-speed drives, some mounted in the countershaft, others on top of the housings, and still others in the bed. In bringing out the design, shown in Figs. 1 and 2, it has been the aim to avoid some of the objections of the other plans mentioned above. Particular attention has been given to reducing mechanism, too much of an opportunity for wearing, a tendency towards vibration and other similar drawbacks.

It was considered in designing this machine that two speeds for the cutting stroke would practically cover all conditions, since the planer, while requiring a variable cutting speed, does not demand so wide a variation as other machine tools. In practice, it was concluded that a slow speed for roughing and a higher one for finishing, cover the requirements satisfactorily. The planer here shown has been provided with a new shifting mechanism, and has two speed changes in the bed, as shown plainly in the line drawing in Fig. 2.

The usual belts and driving pulleys are retained. *A* and *B* are the loose and tight forward-stroke pulleys, while *C* and *D* are the loose and tight quick-return pulleys, respectively. The loose pulleys are of wider face than the tight pulleys, and unlike the latter, which are made as light as possible, are provided with heavy balance wheel rims. The purpose of this is to assist in the reversing of the machine without throwing the usual destructive strain on the high-speed belting. Light, double 2¾-inch wide belts are used,

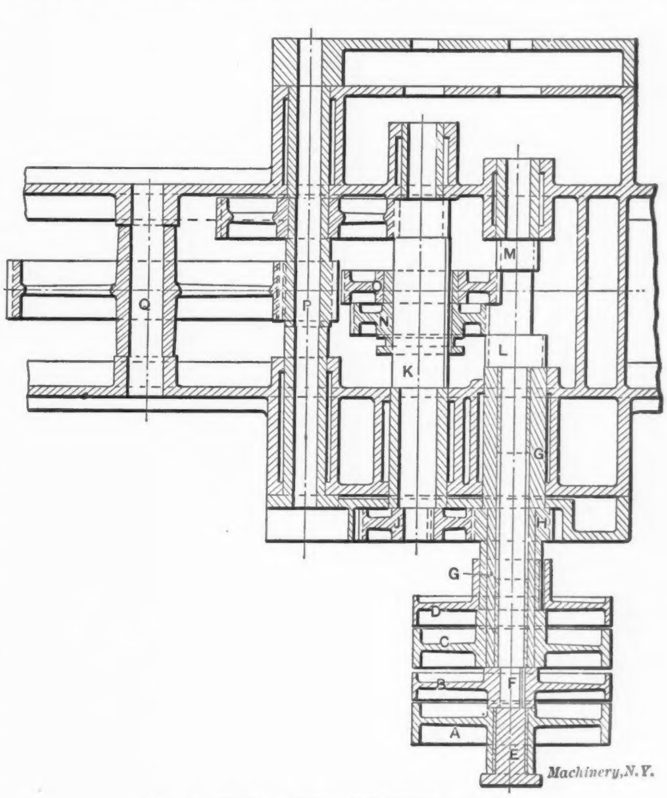


Fig. 2. Speed Change Mechanism in Bed.

without slipping or flapping. It will be noted that these belts are wider than the tight pulleys *B* and *D*. This means that they are constantly in contact with the balance wheel pulleys *A* and *C*, so that the effect of these heavy revolving rims is applied directly to reversing the planer table.

The gearing connections will be easily understood from a study of Fig. 2. Driving pulley *B* is keyed to the driving

shaft F, which carries, inside the bed, pinions L and M, which mesh with corresponding gears N and O on intermediate shaft K. These latter gears can be shifted so that O will be driven by M, or so that N will be driven by L, thus giving the two rates of cutting speed for the forward drive. The reverse is operated by tight pulley D, which is keyed to the hub of pinion H, meshing with gear J on intermediate shaft K. The speed of the return is thus constant, irrespective of the position of sliding gears N and O. The latter are shifted by a block fastened to a rod, which has rack teeth at its outer end engaging a pinion on a rock shaft, operated by the handle shown at the right of the shifting mechanism in Fig. 1.

An ingenious and effective point in the design of this machine relates to the mounting of the four pulleys A, B, C and D. The loose pulleys A and C are each independently mounted on stationary bearings of their own. The forward loose pulley A revolves on a stationary journal E, which is a part of the heavy overhanging cast iron arm, which contains the shifting mechanism, as shown in Fig. 1. It has no connection whatever with drive shaft F, so that the latter is relieved from the belt pull, except when it is itself being driven. Loose pulley C is likewise supported by a stationary bearing; in this case, quill G, which is seated in a bored hole in the frame as shown. On this quill also revolves pinion H and pulley D, keyed to it, as previously described. Since the loose pulleys are provided with stationary bearings, excessive wear, heat and friction caused by the customary practice of having pulleys revolved in one direction on shafts rotating in the other, are eliminated. This amounts to a cutting down of the number of revolutions of the loose pulley on its bearing by almost a half a million revolutions per day, and brings, consequently, an appreciable reduction in the friction loss. Bearings of both loose pulleys are of large diameter and are very rigid; they are provided with suitable arrangements for oiling.

Another change incorporated in this design relates to the belt shifting mechanism, which has here been designed to employ the drum type of cam. This has been found to operate more easily and give a quicker action than the plate cams formerly used. The planer herewith shown was arranged for giving cutting speeds of 26 and 45 feet per minute, with a constant return of 120 feet per minute. Its operation has been very satisfactory.

BAIRD FOUR-SLIDE AUTOMATIC WIRE FORMING MACHINE.

The Baird Machine Co., Oakville, Conn., has placed on the market the four-slide automatic wire forming machine illustrated herewith. Machines of this type have become the standard for general work in wire bending, being adapted to the shaping of all except unusually complicated or special forms. This type of machine may be fairly considered as universal in its range, since by means of the various adjustments provided, and by the use of suitable formers, work of great variety may be produced. The makers of the new design shown herewith have had the benefit of long experience in the operation of wire machinery, and have thereby been enabled to include in this design many features that make for increased efficiency. The machine has the advantages of few and simple adjustments, accessible mechanism, easily acting cams, ample bearings and rigid construction.

The general design of the four-slide automatic wire forming machine, as best seen in Fig. 2, provides for a working table with shafts on its four sides, carrying cams operating corresponding slides, which approach the work from four different directions. The left-hand cam-shaft also operates an automatic feeding mechanism, which draws the wire through the straightening rolls, and feeds it so as to be cut off to the proper length to suit the work. The wire straightening rolls shown at A are so arranged as to face the front, leaving the wire in plain view of the operator while it is being straightened.

A simplified feed mechanism is used. As plainly shown in Fig. 1, it is operated by a slotted crank whose length of stroke is varied by the knurl-headed screw shown at B in Fig. 2. For accurate feeding, positive stops C are provided for the feed slide. These stops are quickly and easily set. This mechanism is designed to be an improvement over various geared and slotted lever arrangements previously used, or the friction device sometimes employed. The adjustments for length of feed are operated independently of the feed grip. Neither the latter nor the binding cam requires any adjustment, as the time for gripping and releasing is practically the same for all lengths. The feed throw-out is shown at L.

The cut-off is quickly and easily adjusted by the loosening of cam bolt D, and the turning of stud pinion E, which engages a rack by means of which the proper change is more

Fig. 1. The Baird Four-slide Automatic Forming Machine for Wire Goods.

easily and delicately effected than by the more common method of tapping the bracket in either direction until the right adjustment is reached.

Another advantage of the machine is the employment of a swinging former F, which permits the use of either a stationary or moving form without change of bracket. The form-holder is suspended from a pivot, and held in line with the wire by a spring; it is carried back by the front tool against the abutment of the heavy, solid bracket. This arrangement permits higher speed and easier movement than is possible when a heavy slide is used in place of the swinging former. The adjustments of the form bracket are shown at K.

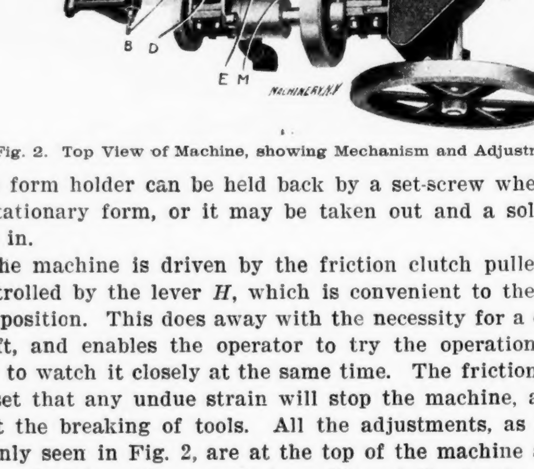


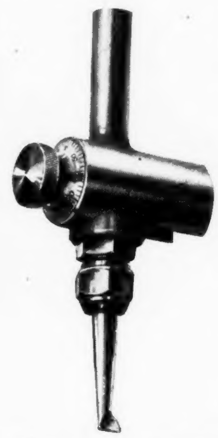
Fig. 2. Top View of Machine, showing Mechanism and Adjustments.

The form holder can be held back by a set-screw when using a stationary form, or it may be taken out and a solid form put in.

The machine is driven by the friction clutch pulley at G, controlled by the lever H, which is convenient to the operating position. This does away with the necessity for a counter-shaft, and enables the operator to try the operation slowly and to watch it closely at the same time. The friction can be so set that any undue strain will stop the machine, and prevent the breaking of tools. All the adjustments, as may be plainly seen in Fig. 2, are at the top of the machine and can be reached from the operator's position at the front. Adjustments for the tools are shown at J, for the form bracket at K, and for the stripper at N. These machines are made in six sizes, from No. 0 to No. 5, working wire up to $\frac{3}{8}$ inch in diameter and 15 inches long.

PRECISION BORING TOOL.

The illustration shows a boring tool adapted to be held in machines with rotating spindles, such as drill presses, milling machines, lathes, etc. It is provided with means for adjusting the diameter of cut made by the rotating tool, so that the workman may know the amount he is removing with each chip. As shown, the main member is a sleeve having a solid shank at right angles to it, by means of which it is held in the spindle of the machine. In this sleeve is carried a tool-holder, adjustable for different diameters by means of a screw having a knurled and graduated head. These graduations read to thousandths of an inch, permitting a high degree of accuracy in operation. The adjustment, when made, is locked by the upper nut shown on the tool-holder shank. The boring tools themselves are held in the split end of the spindle by tightening the lower of the two nuts.

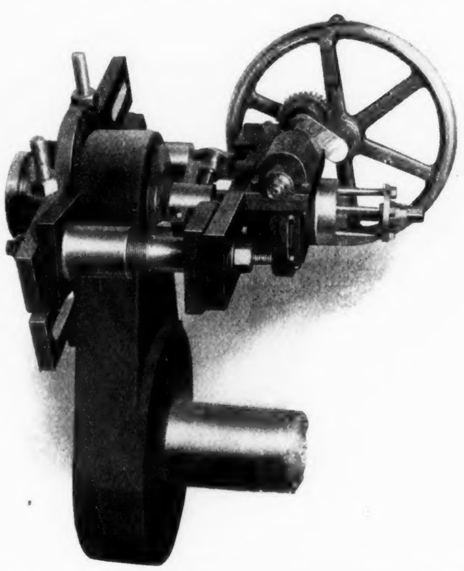


Rotating Boring Tool with Micrometer Adjustment for Diameter.

The body and holder of this tool are made from drop forgings. The cylinder, tool-holder and lock-nut are carbonized to increase their durability. The device will bore holes up to 3 inches in diameter. It is made by the Precision Boring Tool Co., 210 Wetherbee Building, Detroit, Mich.

UNDERWOOD PORTABLE BORING, TURNING AND FACING MACHINE.

The latest addition to the line of portable tools made by H. B. Underwood & Co., 1024 Hamilton St., Philadelphia, Pa., is shown herewith. It was originally designed for the special work of cutting out the countersink for removing riveted crank-pins. This is a laborious and time-consuming operation when done with a hammer and chisel. The mechanism is mounted on a solid cross-head which carries a casing containing a worm-wheel, journaled on large integrally formed hubs.



Machine designed for Cutting out Riveted Crank Pins, but adapted to General Facing, Turning, etc.

The cutting spindle has a sliding movement of 4 inches through the worm-wheel, the feed being operated by hand. The end of the spindle carries a steel slide for the cutting tool. This is adjustable for different diameters by the screw shown, the maximum diameter being about 12 inches.

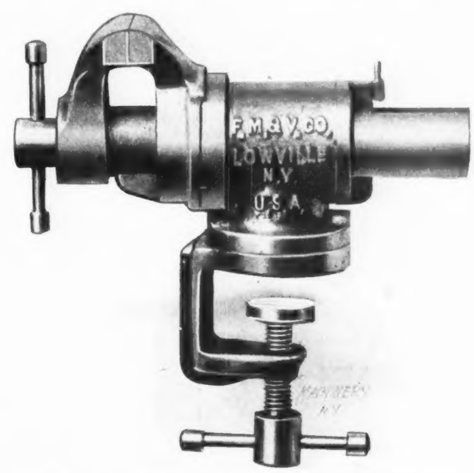
Two clamping plates, with centers cut to a V-shape, which will take a wide range of sizes, clamp the device to the work, being tightened together by 1-inch through bolts. Separate adjustable spacing blocks, or studs threaded to receive each other, may be used for straddling cranks, the spokes of locomotive drivers and other work of varying dimensions. Bolts passing through these blocks clamp the machine proper to the cross-heads. The entire arrangement is very firm and solid, and each piece is light enough to be easily handled by one man. The machine is quickly centered.

Three changes of speed, for heavy, medium or light work, are provided. These speeds are obtained by interchanging the gears shown on the driving shaft, or by driving direct without them. The spindle is at right angles to the base or cross-head, and by means of an extra facing attachment can be used for facing off pump or engine valve seats, it being immaterial whether or not the steam chest is solid, or the valve seat several inches below the face of the chest. The machine may be driven by hand or any other suitable power.

As may be seen, the range of usefulness of this device is much greater than the operation of removing riveted crank-pins, for which it was first designed. It may be employed, for instance, in facing up a pipe flange that is out of true. It is practically a universal boring, turning and facing machine for work within its range.

PORTABLE DOUBLE-SWIVEL VISE.

The Fulton Machine & Vise Co. of Lowville, N. Y., builds the universal, vertical and horizontal swivel vise illustrated herewith. It is of a size which is particularly suitable for motor boat and auto equipment, though of course it may be



A Vise adapted to Motor Boat and Automobile Use.

used wherever a small swivel vise is required. A special adaptability to automobile use is given by the universal adjustment, as it is otherwise often impossible when working in a small space, to hold the work with the full length of the jaws. Both swivels are clamped tightly by the gripping of the work, which will slip before the swivels will change position. When the work is gripped, all lost motion is taken up, and the whole tool becomes as rigid as a solid jaw vise. It is claimed by the makers to be stronger than any solid jaw design of the same capacity, having nearly twice the weight.

The jaws are steel faced and tempered, the finished parts are nickeled, and other parts are painted with best black enamel. The nut is of malleable iron, and is of the same diameter as the body, having a bearing around the entire outer edge. There are no levers or pivots in the adjusting mechanism to break or wear out. The jaws are two inches wide, and open two inches, and the tool weighs $7\frac{1}{2}$ pounds. It is adapted to be fastened by the clamp shown, to the running board, or any other suitable support.

* * *

In a letter to the Department of Commerce and Labor, Consul-General S. Listoe states that the ancient Dutch windmills are slowly giving way to more modern prime movers, and that gas engines are being introduced in many places, to take the place of the windmills. The reason for abandoning the windmill is the uncertainty of its motive power. At the same time, however, it should be noted that in Denmark, extensive experiments have been made with windmills as motive power for electric machinery, and that plants provided with supplementary gas engines for use when the wind fails, have proved satisfactory. Some small Danish towns have built electric lighting plants operated in this manner.

NEW MACHINERY AND TOOLS NOTES.

Double Stroke Open Die Header. E. J. Manville Machine Co., Waterbury, Conn. This is a new size of the builders' well-known machine design, for the cold heading of parts made from wire up to ½ inch diameter.

Electricians' Screw-Driver. L. S. Starrett Co., Athol, Mass. This tool is similar to the makers' telescopic pocket screw-driver, except that the handle is made of insulating material, fitting it particularly for electricians' use.

Solder File. Hayes File Co., Detroit, Mich. This firm has recently commenced the making of files of a special cut, particularly adapted to work on solder, babbitt and other metals of a similar character, which rapidly fill the teeth of the ordinary file.

Combined Triangle, Scale, Protractor and Erasing Shield. D. J. Kelsey, New Haven, Conn. This drafting instrument is a combination of the various tools mentioned, being an extension of the maker's well-known combination 30, 45 and 60 degree triangle.

Foot Press. La Salle Machine & Tool Co., La Salle, Ill. This foot press is mounted on a table supported on legs, which allow free movement for the operator. It is solidly built and provided with adjustments which maintain its proper action for an indefinite period.

Duplex Die Stock. Borden Co., Warren, O. This tool, which the makers call the No. 6 Beaver die stock, is provided with two sets of chasers, either of which can be used as desired. A single cam changes from one set to the other, and adjusts each set to the proper size.

Pneumatic Chipping Hammer. Pittsburg Pneumatic Co., Canton, O. This is a compact chipping hammer, provided with an air cushion arrangement which reduces vibration to a minimum. It is made in six sizes, weighing from 4½ to 10 pounds, with strokes ranging from ½ to 4 inches.

Radius Gage. L. S. Starrett Co., Athol, Mass. These tools are provided with both concave and convex radius gage surfaces ranging from 1/16 to ½ inch radius for the small size, and from 17/64 to 1 inch for the larger size. They are intended for general use of tool-makers, pattern-makers, etc.

Steel Drafting-Room Table. The Century Mfg. Co., Columbus, O. This is made of angle, flat and round stock throughout, and is so braced as to be very rigid. It can be folded up and adjusted to various positions as may be required. Parallel ruler, and a bracket and tray will be furnished when desired.

Monorail Electric Hoist. Alfred Box & Co., Philadelphia, Pa. These hoists are designed to run on I beams, and are furnished in either the hand- or power-traverse styles, the hoist being operated by an electric motor. Two brakes are furnished, one mechanical and the other electrical, to prevent accident while under load.

Emery Wheel Stand. George H. Calder, Lancaster, Pa. This stand is made in five sizes, for maximum diameter of wheels from 6 up to 15 inches. Special attention has been given to rigid construction; a feature of the design is the placing the table low enough to avoid the danger of breakage, by getting a casting between it and the wheel.

Engineers' Gage. L. S. Starrett Co., Athol, Mass. This gage is of the familiar swinging leaf type employed for various forms of gages. This particular instrument comprises a taper gage reading 64ths per foot, nine feeler gages from 0.002 to 1/16 inch and a wire gage graduated in numbers on one side and decimal measurements on the other.

Tilting Tumbling Barrel. Clark Novelty Co., Rochester, N. Y. This barrel is of the open-end type, provided with a mechanism for setting it at any angle, and thus emptying it and refilling it while in motion. The barrel will be furnished either in cast iron, sheet steel or wood. The machine was developed for use in the shops of the makers.

Tilting Vise For Drill Press, Planer, Shaper, Etc. Blissfield Motor Works, Blissfield, Mich. This tool, called the "Davenport" tilting vise, can be adjusted to any position from the horizontal to the vertical, being supported by diagonal braces at the desired angle. The jaws are 2 inches high and 5 inches wide, and open 6 inches.

Bench Drill Press. Blissfield Motor Works, Blissfield, Mich. The "Davenport" bench drill has the form of the standard drill press on a small scale. It is furnished with a two-step or three-step pulley, as required by the purchaser. It will drive drills up to ¼-inch diameter to the center of a 7½-inch circle.

Combined Forming and Bending Machine. Royal Mfg. Co., Lancaster, Pa. Intended for forming and bending light shapes for general steel work. It will bend small rings or circles of various sections up to the equivalent of ½ inch square stock. A plating and crimping attachment is furnished for ornamental work.

Twelve-Foot Boring Mill With Slotting Attachment. Betts Machine Co., Wilmington, Del. This is a regular boring mill except for the fact that it is provided with a 12-inch boring bar and a slotting attachment, which fit it for the economical finishing of central holes in pulleys, etc., and the splining of the keyways without removing the work from the boring mill table.

Elgin Counter-shaft for Precision Lathes. Elgin Tool Works, Elgin, Ill. This self-contained counter-shaft may be mounted on column supports on the work bench, or on brackets attached to the wall. Convenient provision is made for forward or reverse speeds, and for driving milling attachments, grinding attachments, etc., at any point in the length of the lathe bed.

Centering Device. Patterson, Gottfried & Hunter, New York City. This device consists of a series of blocks, so connected by sliding shafts that they move together simultaneously toward the central bushing, which is thus centered when the blocks are brought down around a piece of square or round stock. The center is then marked by a prick punch, guided by the bushing.

"Perfect" Power Hammer. Macgowan & Finigan Foundry & Machine Co., St. Louis, Mo. This hammer is of the direct action type in which the crank is mounted directly above the ram. It has an adjustable connecting rod and adjustable spring tension. It is made in three sizes, the rams weighing from 30 to 80 pounds. The largest of this line of hammers will work iron up to 3½ inches thick.

Self-Contained Gear Reduction Mechanism. Newark Gear Cutting Machine Co., 66 Union St., Newark, N. J. This device as furnished is formed of an oil-tight casing, containing a train of worm and spur gearing giving four speed changes. It is particularly adapted to direct connection with a motor for driving slow speed machinery, such as annealing and hardening furnaces, etc., at varying rates of speed.

Universal Joint. Michigan Wheel Co., Grand Rapids, Mich. This joint is ordinarily designed for propeller shafts, but can evidently be applied to other purposes. Center blocks, forks and journal pins are of steel, the latter being hollow to serve as a reservoir for oil, supplying enough for an ordinary season's service without refilling. The forks are bronze bushed under hydraulic pressure, and are ground to fit the journal.

Roller Relief Bearings. Pickering Governor Co., Portland, Conn. These bearings are intended for supplementary or emergency use, to relieve the strain on overloaded bearings wherever necessary. Each consists of a roller supported on internal roller bearings, and provided with adjustable mountings for jacking up and supporting the shaft. They are made in sizes to be used for all purposes from light counter-shafts to engines of moderate size.

Ball Thrust Bearing. International Engineering Co., 1779 Broadway, New York City. The "R. B. F." ball bearing has been placed on the market in a style to operate as a double acting thrust bearing. These bearings are self-contained units, and may be handled as one piece. The races are held in spherical seats, which permit change of alignment without disturbing the accuracy of its action, and without disturbing the distribution of the load on the balls.

Combined Steel and Hemp Belting. Massachusetts Belting Co., 207 Congress St., Boston, Mass. This belting consists of interwoven strands of steel wire served with specially prepared hemp marline. The belt thus formed is protected at the edges by solid steel wire to make it proof against wear from belt shifters, etc. The purpose of this construction is to combine the strength of the steel with the durability and high coefficient of friction of the hemp.

Supplementary Turret for Boring Mills. Bullard Machine Tool Co., Bridgeport, Conn. This turret tool-holder fits in the tool-slide in place of the regular tool head, and may be rotated about a vertical axis to bring a succession of cutting tools into action. There are four faces to the device, permitting the holding of four tools in each head. The saving is considerable as compared with the taking out and replacing of tools in manufacturing work with the regular tool head.

Universal Attachment for Milling Machines. Porter-Cable Machine Co., Pearl & Canal Sts., Syracuse, N. Y. This attachment is universally adjustable to fit any commercial milling machine having an overhanging arm. It is intended particularly for high-speed milling. The spindle is driven by bevel gears and belting from the main spindle of the machine, and may be set at any angle about two axes at right angles to each other, thus giving it a full universal adjustment.

Centering Lathe. Climax Co., Hyannis, Mass. This is a specialized form of lathe, having a large hollow spindle, with a chuck at each end for supporting the stock. The centering drill is operated by a second revolving spindle on the tailstock. For accurately centering finish work, a steady rest is provided; in this case only one of the chucks is used—either the one on the inner or the outer end of the hollow spindle, as is required by the work. The drill runs at 600 revolutions per minute, and the chuck at 25 revolutions per minute.

Internal Grinding Machine. Bath Grinder Co., Fitchburg, Mass. This grinding machine is unique in being provided with two spindle heads, and in having the work mounted in a revolving sleeve. This makes it possible to mount the wheel in the middle of a separable spindle, driven at both ends, thus giving a far stiffer support than is usually obtained and resulting in an increased output. The machine is heavily made, to minimize trouble from vibration, and is fully provided with the various adjustments and attachments necessary for the work it is called on to perform.

Automatic Air-Controlled Nut Tapping Machine. Pneumatic Nut Machinery Co., Cleveland, O. In this machine a horizontal six-sided turret is provided, carrying six revolving taps. Automatic magazines and pneumatic feeding mechanisms on each side of the turret feed nuts into the taps as they are successively indexed into position in front of them. An automatic stopping mechanism pulls the tap clear off the chuck and removes the nut from the shank, replacing the tap ready to receive a new nut when it again arrives in front of the feeding mechanism. The machine faces the nuts as well as threads them.

Threaded Adjustment for Micrometers, Drill Spindles, Screw Jacks and Other Uses. F. E. Bocorselski, Supt., Baush Machine Tool Co., 200 Wason Ave., Springfield, Mass. This form of adjustment comprises a nut, threaded to a hollow sleeve, which is provided with a slot through which passes a cross-arm; on this the inner member is supported, so that by the turning of the outside threaded collar or nut the entire member is adjusted longitudinally. This construction has been applied by the inventor to ratchet drills, micrometers, screw jacks, etc., and to the individual adjustment of drills for multiple spindle machines.

Single Crank Power Press. Toledo Machine & Tool Co., Toledo, O. This press is unusually large for its type, and is intended for making stampings from heavy gage metal. It is provided wlith an automatic releasing clutch for stopping the press at the high point of the stroke, and a hand lever control for stopping and starting the press anywhere at will. The press frame is of the four-piece construction, reinforced by four heavy steel tie-rods. The stroke is 24 inches, and the pressure capacity about 1,250 tons. The friction drive releases instantly when the press is subjected to an overload of 25 per cent greater than this amount.

Multiple Spindle Drilling Machine. Cummings Machine Co., 238 William St., New York City. This drilling machine is of the type in which a multiplicity of spindles are mounted so as to be set to any required layout. A number of new features are provided, not common in machines of this kind. Methods of holding the various spindles and adjusting them to the required position have been carefully worked out, and are unusually convenient. The center-to-center distance has been reduced to a very small dimension, it being possible to drill four 29/32 holes with the centers at the corner of a 1 1/32 inch square. Each drill spindle is driven through a flexible jointed shaft from an independent, self-contained spiral gear drive. These drives may be readily changed to give different speed ratios, thus driving drills of various sizes in a given layout at the various speeds required for effective work.

* * *

THE CLERMONT REPLICA FOR THE HUDSON-FULTON CELEBRATION.

The officers of the Hudson-Fulton Celebration Commission have let the contract for building a replica of Robert Fulton's *Clermont* to the Staten Island Shipbuilding Co. Work has already begun on the copy of the first boat to steam up the Hudson, and the contract calls for its completion by August 1. The boat will be a duplicate of Fulton's first boat, will run under its own steam with a boiler and engine exactly like those which Fulton had built, and will be able to attain the same speed as the *Clermont*—four to six miles an hour! The only differences between Fulton's boat and that which is being built for the celebration next September are those which the steam boat inspection laws make necessary. If the steamboat inspection department had been in existence when Fulton started on his first trip up the river, he probably would not have been allowed to proceed without stopping to put on safety valves, life preservers and other appliances which the present steamboat laws require.

Except for these differences and a slight change in the width of the boat which the steamboat inspection laws require the *Clermont* which is building now will be exactly like that which made the residents along the Hudson in 1807 believe that the earth was coming to an end. She will have the same uncovered side paddle wheels which splashed water on her first passengers, the same little square cabin forward and the same awkward engine and machinery which, however, made practical the navigation of the Hudson without the necessity of waiting for a favorable wind. To be sure, the average speed of the *Clermont* on its first trip was only 4.6 miles against the wind, but this was such an improvement over the average speed of the sailing vessels that it was the cause of great rejoicing.

The search for accurate data on Fulton's first boat by the committee in charge was a long and arduous one. There was plenty of data concerning his subsequent boats, but there appeared to be very little concerning the first boat that steamed up the Hudson. Drawings of her engine were finally found, and from a letter of Hudson's which was unearthed it was learned what the hull of the boat looked like.

The original *Clermont* was 150 feet long and 13 feet wide, with 7 feet depth of hold. She drew 2 feet of water. Her hull (below the deck) had wedge-shaped bow and stern, cut sharp to the angle of sixty degrees. In horizontal plan the sides were parallel and she was almost wall-sided, being a very little wider on deck than on the bottom, which was flat and without a keel. She had two steering-boards or leeboards to prevent drifting sideways. She had two masts, but no bowsprit or figurehead. There were two cabins, one forward and one aft. The tiller was at the back end of the after cabin, so that it was difficult for the helmsman to see what lay ahead. The engine, built in England, was amidship between the two cabins and was uncovered. The boiler was of copper. The paddlewheels, 15 feet in diameter, were uncovered, which resulted in drenching the passengers, and no guards protected the wheels from collision. Later the paddlewheels were covered. To turn the vessel around one paddle-

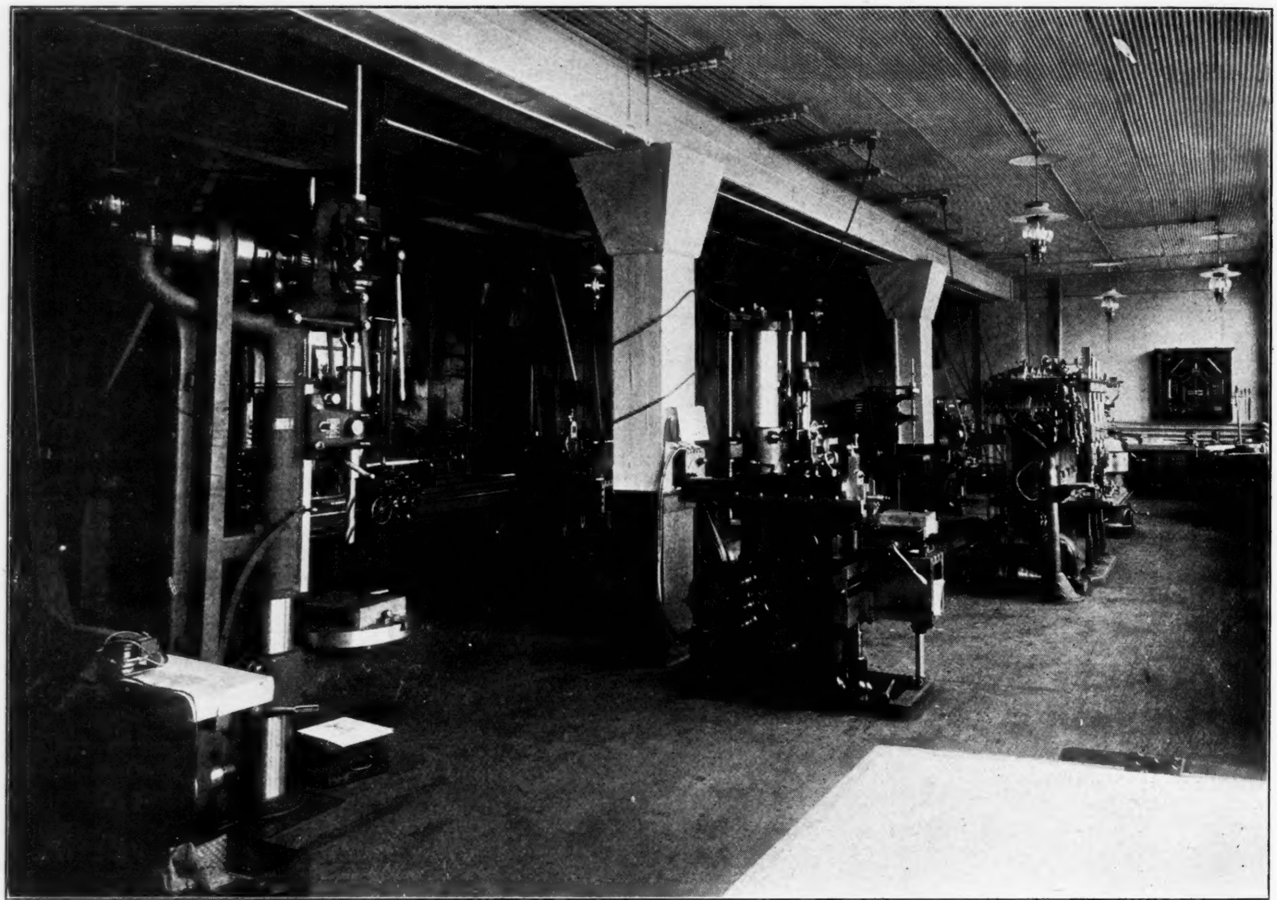
wheel was disconnected. The flywheels of the engine were outside of the hull forward of the paddlewheels, and revolved the same way. On one occasion, when one of the paddle-wheels was disabled, it is said, paddles were attached to the flywheel and the voyage continued.

The *Clermont*, with the replica of Hudson's *Half Moon*, which is being built in Holland, will be the center of the great naval parade which will start from New York and steam to Newburgh on Friday, October 1. To convoy these two little vessels there will be fleets of American and foreign warships, great river craft and ocean steamships that have evolved from Fulton's awkward little steamboat.

* * *

A NEW MACHINE DEMONSTRATING ROOM.

On Saturday evening, February 20, the Marshall & Huschart Machinery Co., of Chicago, opened its new demonstrating room and many men prominent in the machine world were present. The speakers of the evening gave some very interesting and instructive talks, illustrated by practical examples on the machines. Chas. S. Gingrich, of the Cincinnati Milling Machine Co., spoke on "Milling Machines"; S. H. Peck of the Rockford Drilling Machine Co., spoke on "Multiple Drilling"; E. P. Bullard, Jr., of the Bullard Machine Tool Co., talked on "Boring Mill Practice," and J. W. Carrel of the Lodge & Shipley Machine Tool Co., completed the list of speakers with his talk on "Lathe Practice."



New Demonstrating Room of the Marshall & Huschart Machinery Co., Chicago, Ill.

The new demonstrating room was fitted up to actually show what the various machines can do. No set pieces are kept in the machines, but they will be set up and tried out on any job that a prospective purchaser calls for, and as the equipment of the room is unusually complete in machines, tools and material, the demonstrations promise to be very valuable to the "man from Missouri." E. V.

* * *

NEW PACKING MATERIAL FOR ANNEALING STEEL.

It is commonly known that steel gains in strength and uniformity of its structure by slow heating to a certain high temperature, followed by slow cooling, but it is only recently that the requisites for successful results have been well understood. Most important among them are the correct ultimate maximum temperature and the very slow and uniform heating and cooling. To secure this latter, some sort of covering must be given to the steel to be so heated, to prevent rapid cooling and oxidation of the surface. Such a protecting packing must be a good heat insulator, that is, allow heat to pass through it but slowly, and also must contain no constituents liable to affect the quality of the steel, either through fusing or oxidation. This requires that the packing shall be infusible at the temperatures used and shall not be capable of absorbing gases.

There are numerous packings which have been used for this purpose with more or less success. Some compositions are secret and highly expensive, others are lacking in uniformity and hence unsatisfactory, while others are satisfactory within certain limits. The Laurentide Mica Company, Ltd., Box 911, Pittsburg, Pa., has just placed on the market a product known as "Micanneal," which has proven itself to be the superior of the packing ordinarily used for this purpose. It is infusible, will not absorb gas and is a remarkably good heat insulator. Therefore it prevents the steel from being heated or cooled too rapidly, and also protects it from oxidation. The specimens come out clean when packed in Micanneal, whereas such combinations as are ordinarily used are scaly. Under the same circumstances specimens packed in Micanneal will require from 25 to 150 per cent longer to heat and to cool than with any other packing, which insures greater uniformity of the steel. Micanneal is prepared in different degrees of fineness from the coarsest to the finest mesh. It is ordinarily sold in lots of approximately 100 pounds.

* * *

An alloy made of 70 per cent nickel and 30 per cent copper, and known as monel metal, has recently been placed on the market by the Orford Copper Co., Bayonne, N. J. According to the *Engineering and Mining Journal*, the tensile strength of the material is about 108,000 pounds per square inch, and the elastic limit of rolled, annealed and cold drawn material is 98,000 pounds per square inch. It is stated that the roof of the new Pennsylvania Railroad station in New York City will be covered with sheets of this alloy.

PERSONAL.

A. J. Dinkel is now the superintendent of the Lisle Mfg. Co., Clarinda, Ia.

Walter B. Snow, Boston, Mass., has been elected a member of the corporation of the Massachusetts Institute of Technology.

John D. Powers, for some years past in charge of the hacksaw department of H. Disston & Son, Inc., Tacony, Pa., severed his connection with that concern on March 31.

James W. Ogden, formerly superintendent of the Bridgeport Foundry & Machine Co., Bridgeport, Conn., is now superintendent of the Wolverine Motor Works, Bridgeport.

George Chase, formerly superintendent of the Pacific Iron Works, Bridgeport, Conn., is now superintendent of the Lake Torpedo Boat Co., Bridgeport.

A. L. Mitchell, for some time round-house foreman for the Wabash R. R. at Decatur, Ill., is now general foreman of the C. P. & St. L. Ry. shops at Springfield, Ill.

W. A. Hopkins, electrical engineer for the Wabash Ry., is now engaged in installing the electrical machinery for the new drop-pit in the Wabash shops at Springfield, Ill.

The successor of Edmund Pennington as vice-president and general manager of the Soo Line, will be John M. Egan, who for several years has been general manager of the Great Western Railroad.

The official photographer of the E. R. Thomas Motor Co., Buffalo, N. Y., is Miss Mimmette Ives Meade, who probably is the only woman in the United States making a specialty of machine shop photography.

H. W. Heidenger, a graduate of Rose Polytechnic Institute, Terre Haute, Ind., has been made mechanical engineer of the Baltimore & Ohio Southwestern Railroad, with headquarters at Washington, Ind.

A. B. Fleming, purchasing agent of the Fairmont Mining Machine Co., Fairmont, W. Va., has resigned his position, and Clarke Evans, secretary of the company, will attend to the purchasing hereafter.

Henry Dreses, president of the Dreses Machine Tool Co., Cincinnati, Ohio, spent a greater part of February and March on a pleasure trip in Cuba, Florida and other Southern parts.

Charles Sterne, mechanical engineer of the Baltimore & Ohio Southwestern Railroad, formerly located at Washington, Ind., has been transferred to Louisville, Ky., to act as round-house foreman.

J. M. Robinson has resigned his position of assistant superintendent of the Chapman Valve Mfg. Co., Springfield, Mass., and has been made assistant manager of the Henry R. Worthington Co., Harrison, N. J.

J. A. Bennett, for ten years with the Pratt & Whitney Co. and later foreign representative for the Niles-Bement-Pond Co., has been made mechanical engineer of the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio.

L. G. Nilson, chief engineer of the Strang Gas Electric Car Co., 15 Wall St., New York, has been elected president of the Nilson-Miller Co., Hoboken, N. J. Mr. Nilson will continue as consulting engineer for the Strang Gas Electric Car Co.

D. O. Ives, chairman of the official classification committee of the Trunk Lines' Association, New York, and former general traffic manager of the Wabash R. R., has been made secretary of the New England Board of Trade and Transportation.

George F. Fenno, for two years past insurance engineer with the Middle States Inspection Bureau, an organization maintained by thirty-six of the leading fire insurance companies, has joined the staff of the George H. Gibson Co., Tribune Building, New York.

Isidor Rauh, for many years president and general manager of the Cincinnati Electrical Tool Co., Cincinnati, Ohio, has resigned his position and has been succeeded by I. W. Becker. Mr. Becker is well and favorably known throughout the Middle West.

Henry Hair, son of John M. Hair, superintendent of motive power of the Baltimore & Ohio Southwestern Railroad, who succeeded Mr. Charles Sterne, formerly mechanical engineer, has been transferred to Seymour, Ind., to act as round-house foreman.

Fred J. Miller, vice-president of the A. S. M. E., became on March 1 connected with the Union Typewriter Company of New York, with the title of Assistant to the President. He will devote himself especially to matters connected with the manufacuring department of the company, which has factories at Ilion, Syracuse and Bridgeport.

J. W. Bray, who formerly represented the Bullard Machine Tool Co., Bridgeport, Conn., in New England territory and for the past year was located in Philadelphia, has returned to the Bridgeport headquarters and will travel in New England territory again. Mr. R. H. Snider has taken charge of the Philadelphia office at 1414 South Penn Square.

A. Eugene Michel has opened an advertising office at 1572 Hudson Terminal Buildings, New York. Mr. Michel is a graduate engineer, and has had eleven years advertising and engineering training. He will confine his advertising work principally to steam specialties and apparatus, power transmission appliances, and machine tools.

Prof. Lester P. Breckenridge, head of the mechanical engineering department of the University of Illinois for several years, has been made professor of mechanical engineering at Yale University and a member of the governing board of the Sheffield Scientific School. Prof. Breckenridge succeeds Prof. C. B. Richards, who resigned after twenty-five years service.

E. V. Thompson, for some time assistant superintendent of motive power of the Chicago & Northwestern Railroad Co. at the Chicago shops, has been made superintendent of motive power of the Chicago, St. Paul, Minneapolis & Omaha R. R., with headquarters at St. Paul, Minn. He is succeeded at the Northwestern shops by Mr. E. W. Pratt, who was master mechanic west of the Missouri River.

Price H. M. Brooks, for many years foreman of the Hill shop and Water shop of the United States Armory, Springfield, Mass., has resigned his position. The position has been abolished, and hereafter the Hill shop and Water shop will be under independent foremen. Donald J. Manning has been made foreman of the Hill shop and C. H. Ladd continues as foreman in charge of the Water shop.

Robert Thurston Kent has resigned as engineering editor of the *Iron Trade Review*, Cleveland, Ohio, to become managing editor of *Industrial Engineering*, Pittsburg, Pa., a new paper devoted to mechanical engineering subjects. Mr. Kent has been with the *Iron Trade Review* since 1905, and prior to that time was associate editor of the *Electrical Review*, New York.

George A. Spooner, for some years inspector of tools at the United States Armory, Springfield, Mass., has been made master armorer, a title that has been revived. The master armorer has charge of all the master gages and tools required for absolute interchangeability of the parts of the guns made in the Springfield, Mass., and Rock Island, Ill., armories. There has been no title of master armorer at Springfield for over fifteen years. The revival of the title makes no change in the duties.

Arthur C. Hoefinghoff has been appointed sales manager of the Heald Machine Co., Worcester, Mass., beginning March 1. Mr. Hoefinghoff comes from New Orleans, La., where he was located for some time as manager of the machine tool department of the Fairbanks Co. He is a brother of the late Harry C. Hoefinghoff, who was at the head of the Bickford Machine and Tool Co., and was associated with his brother in the management of that business. Mr. Hoefinghoff has had extensive experience in the building and selling of machine tools and is well fitted for his new work.

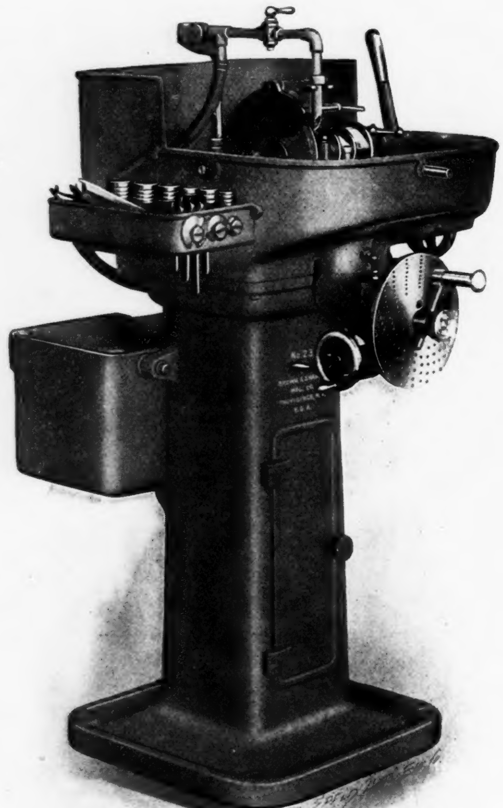
TWO NEW

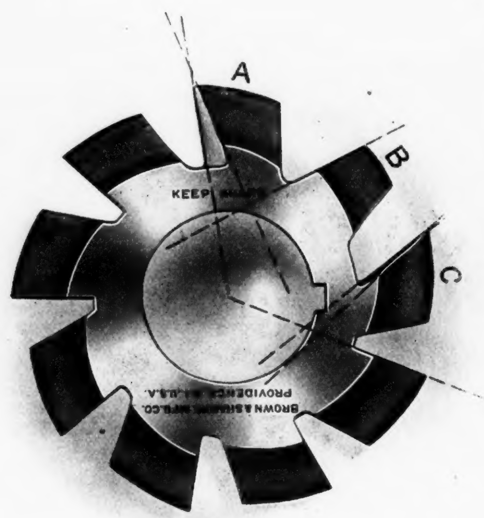
The Gear Cutter Grinding Machine Does Away with the Inaccurate Method of Grinding Gear Cutters by Hand

The form of gear cutter teeth should never be altered or else the accuracy of the cutter is destroyed.

By the aid of an indexing mechanism this machine grinds cutters radially and equidistant, that is without changing their form.

An economical machine to employ where only a few gear cutters are to be ground.





Cut shows how the shape of tooth is lost when ground by hand.

A—Ground on an angle.
B—Ground back of centre.
C—Ground front of centre.

BROWN & SHARPE MFG. CO.

PROVIDENCE, RHODE ISLAND, U. S. A.

Oskar Kylin, formerly designer of special machine tools with the Taylor Iron and Steel Co., High Bridge, N. J., returned on February 26 by the *Adriatic* to New York, after having spent over a year studying the conditions of the machine tool trade and manufacture in various European countries. The main results of his investigations have been published in MACHINERY during the past year in the form of letters and special articles, the latter presenting, with the halftone engravings and concise descriptions, a comprehensive review of the present state of machine tool manufacture in the leading European countries. During his travels, Mr. Kylin went to Germany, Austria, Italy, Switzerland, Belgium, France, England, Denmark and Sweden, visiting the most prominent machine tool manufacturing firms and dealers in these countries.

Einar Morin, formerly in charge of the tool designing department of the Ponds Works of the Niles-Bement Pond Co., Plainfield, N. J., sailed on February 25 by the *La Savoie* for Europe, after a three months' stay in the United States in the interest of his present employers, Stora Kopparbergs Aktiebolag, owners of Domnarfvet's Iron & Steel Works, Borlänge, Sweden. Mr. Morin, who is the author of the series on jigs and fixtures which has been published in MACHINERY during the past year, will spend some time in France and Germany, studying business conditions, and will then return to Sweden, where he will supervise the equipment and take charge of a new manufacturing plant for making machinists' small tools, such as taps, threading dies, cutters, reamers, drills, etc. The series on jigs and fixtures contributed by him to MACHINERY is concluded by the installment in the present issue. We expect, from time to time, to be enabled to publish articles from his pen on interchangeable manufacturing and economical methods of production as developed in his new work.

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OBITUARY.

James Millikin of Decatur, Illinois, president of the Union Iron Works and the Millikin National Bank and founder of the James Millikin University which, with the exception of the State University and the Armour Institute, is the best technical and trade school in the state, died at Orlando, Florida, March 2, aged eighty-two years.

Major Edwin L. G. Zalinski, a retired army officer, an inventor and engineer, died of pneumonia, March 10, in New York, in his sixtieth year. Major Zalinski acquired international fame through his invention of a dynamite gun in which a projectile charged with dynamite was hurled by compressed air. The gun-boat *Vesuvius* was equipped with three of the Zalinski dynamite guns, which threw torpedoes weighing one thousand pounds charged with five hundred pounds of dynamite. The dynamite gun was a practical failure on account of its limited range.

Ervin Saunders, vice-president of D. Saunders' Sons, Yonkers, N. Y., died at the home of his brother in Yonkers, February 17, in his sixty-first year. He was born in Swindon, England, and came to New York with his parents in 1850, and moved to Yonkers in 1854. He entered his father's machine shop at twenty, and after his father's death the firm of D. Saunders' Sons was formed. Mr. Saunders had been in poor health for twenty years and had given more attention to real-estate and his investments than to manufacturing interests. Two brothers, Alexander and Leslie M., survive.

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The enormous number of railway wrecks due to fractured rails has made the need of a higher grade product than the common Bessemer steel rail, very apparent. The open hearth process will in all probability supersede the Bessemer steel process for rail making, but even this steel is not all that could be desired to meet the trying condition of present railway traffic. Heavy engines and high speeds require a rail having physical and chemical characteristics that can be supplied only by some of the alloyed steels. The Bethlehem Steel Co. has, after a long series of experiments, produced a nickel-chrome rail at $51 per ton which, of course, is almost double the present rate for Bessemer steel rails. The standard rail price is $28 per ton for Bessemer steel and $34 for open-hearth steel. It is hardly to be considered that the Americal railways will generally adopt rails that cost $51 except for curves and stretches of track offering particularly difficult conditions.

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COMING EVENTS.

April 27-30.—Annual meeting of the International Master Boiler Makers' Association at Louisville, Ky. H. D. Vought, 95 Liberty St., New York City, secretary.

May 4-7.—Spring meeting at Washington, D. C., of the American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City, secretary.

May 12-14.—Annual meeting of the National Supply and Machinery Dealers' Association, at the Fort Pitt Hotel, Pittsburg, Pa. Secretary-Treasurer A. T. Anderson, 41 Wade Building, Cleveland, Ohio. The association has a membership of 141 manufacturing concerns.

May 18-20.—American Foundrymen's Association convention. Cincinnati, Ohio, Hotel Sinton, headquarters. Richard Moldenke, secretary, Watchung, N. J.

June 1.—Opening of the Alaska-Yukon-Pacific Exposition in Seattle, Washington, which is designed to call the attention of the world to the importance of Seattle as the western gate-way to the United States, and to its rapidly growing commercial importance. The exposition will include many working exhibits, among which are meat packing, watch making, jewelry, silk-making, rope-making, telephoning, printing, etc.

June 1-5.—Annual meeting of the International Railway General Foremen's Association at Chicago, Ill. E. C. Cook, Royal Insurance Building, Chicago, Ill., secretary.

June 7-19.—Cleveland Industrial Exposition, under the auspices of the Cleveland Chamber of Commerce, Cleveland, Ohio. It is estimated that 125,000 different articles are manufactured in Cleveland's 3,500 shops, and it is proposed to display to the world at this exposition the wonderful industrial facilities of the city. The products comprise steel ships, heavy machinery, hardware, twist drills, reamers, milling cutters, wire nails, bolts, nuts, vapor stoves, malleable castings, automobiles, paints and oils, etc. William G. Rose, secretary, Cleveland, Ohio.

June 9-11.—Joint convention of the Southern Hardware Jobbers' Association and the American Hardware Manufacturers' Association at Hotel Shenley, Pittsburg, Pa. F. D. Mitchell, 309 Broadway, New York, secretary and treasurer.

June 16-18.—Annual convention of Railway Master Mechanics' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

June 16-23.—An exhibition of machinery, tools and supplies for the railway supply trade will be held under the auspices of the Railway Supply Manufacturers' Association in connection with the railway conventions at Atlantic City, N. J. Membership dues in the association are $25 per year and carry one badge only. Additional badges may be obtained by members for $5 per badge. Contracts have been let for the erection of exhibition structures covering 59,000 square feet, exclusive of aisles. The charge to exhibitors will be 40 cents per square foot, to cover the cost of erection, etc. The association has prohibited the distribution of souvenirs. Application for space should be made immediately to Mr. Earl G. F. Smith, secretary, 345 Old Colony Building, Chicago, Ill.

June 21-23.—Annual convention of the Master Car Builders' Association on Young's Million-Dollar Pier, Atlantic City, N. J. Joseph W. Taylor, Old Colony Building, Chicago, Ill., secretary.

September 25-October 2.—Hudson-Fulton celebration of the three-hundredth anniversary of the discovery of the Hudson River by Hendrick Hudson in 1609, and the one hundredth anniversary of the successful application of steam to the navigation of the Hudson River in 1807. The headquarters of the commission are in the Tribune Building, New York City, General Stewart L. Woodford, president, and Mr. Henry W. Sackett, secretary. The commission solicits the loan of collections of machinery, models, books, etc., having a bearing on the history of early steam navigation in the United States.

SOCIETIES AND COLLEGES.

THE STATE LEAGUE OF SHEET METAL WORKERS at its recent convention held in Springfield, Illinois, selected Quincy as its next meeting place and chose Robert Byron, the retiring president, to represent Illinois at the national convention in Denver next August. At the concluding session the following officers were elected for the ensuing year: W. E. Mosher, Aurora, president; G. R. Wheelock, Decatur, vice-president; F. W. Efert, Alton, recording secretary; August J. Hernsdorfer, Quincy, secretary-treasurer.

THE EVENING MACHINISTS' ASSOCIATION OF PRATT INSTITUTE, Brooklyn, N. Y., gave its annual dinner at the Machinery Club, New York, March 20th. About one hundred and twenty-five were present, including F. B. Pratt, secretary of Pratt Institute G. D. Pratt, treasurer; A. L. Williston, director of science and technical department, and W. J. Kaup, head of machine department, who is known as the "boss." William Reinicker is president of the alumni association, and John Royals acted as toastmaster of the dinner. The event was a great success, not only as a dinner, but as a manifestation of the strength of the association and the institute's motto: "Help the other fellow."

THE ENGINEERING SOCIETY OF WISCONSIN was organized at the University of Wisconsin, February 24-26. About 150 city engineers, general managers of power and traction companies, construction engineers, superintendents of power and light plants, mechanical and civil engineers, superintendents of highway construction were present and became charter members. Dean F. E. Turneaure, of the College of Engineering, University of Wisconsin, was elected president. The new organization will hold annual meetings for the purpose of bringing together engineers from all parts of the State interested in the solution of problems arising in connection with municipal plants, large construction work, bridge work, water powers, forestry, light and power, etc.

L. C. SMITH COLLEGE OF APPLIED SCIENCES, Syracuse University, has instituted a plan of securing employment for its graduates along the lines of similar plans now in vogue at Cornell and several other technical institutions. An alumni employment committee has been appointed to carry on the work. The committee will keep closely in touch with the graduates and with various engineering interests employing college graduates. A record of the characteristics of the graduates and their work after graduation will enable the committee to recommend men to prospective employers who are likely to fill any reasonable requirement. The advantage of placing graduates through a committee of this character lies in the fact that it has the knowledge and ability to judge a man's capacity even better than the man himself, and fewer failures are likely to result than by employing graduates without the advice of a supervising committee. The work of individuals employed through the committee reflects upon it and tends to make it conservative in all recommendations. It is expected that the result of employment in this way will be very satisfactory to all concerned.